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BOARD OF AGRICULTURE.

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REPORT

ON

FURTHER EXPERIMENTS

IN

CHECKING POTATO DISEASE

IN THE

UNITED KINGDOM AND ABROAD.

(*In continuation of Parliamentary Paper C.* 6647 *of* 1892.)

1893.

Presented to both Houses of Parliament by Command of Her Majesty.

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REPORT

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CHECKING POTATO DISEASE.

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MEMORANDUM.

The experiments on the use of *bouillie bordelaise* as a remedy against potato disease, which were conducted in the United Kingdom and abroad in 1891, formed the subject of a special report which the Board of Agriculture laid before Parliament in 1892 (C. 6647). The following summaries of later experiments of the same class have been prepared in continuation of the information then given.

Although the potato-disease was not prevalent to any considerable extent in Europe in 1892, except in some districts in Ireland, it was present in England and some parts of the Continent in a sufficient degree for the purpose of the further experiments that were carried on in various places to test the preventive or remedial action of sulphate of copper compositions. The results of the later experiments confirm the experience of previous trials and show that the treatment of potato plants with bouillies of sulphate of copper operates in certain circumstances as a check to the malignant affection caused by the fungus, *phytophthora infestans*.

The experiments of 1892 as recorded in the accompanying reports, especially those in England and Ireland, indicate a distinct improvement in the making and applying of the bouillies, as well as in formulating the quantities of their ingredients, and in assessing the cost of their application.

Taking first the experiments carried on for the Board of Agriculture by the Royal Agricultural Society of England, it is seen that although the dressings with bouillie bordelaise did not entirely prevent the potato-disease, they had a marked effect in lessening the extent to which it spread, and gave an increase of crop which more than paid for the cost of treatment. From the conclusions derived from these experiments it is also gathered that treatment with sulphate of copper bouillies serves to arrest the spread of the disease sufficiently, as a rule, to pay for the cost of treatment.

From the careful experiments conducted by the same Society at the Woburn experimental farm, under the superintendence of Dr. Voelcker, it is shown that the application of sulphate of copper compositions had not an entirely preventive effect, but that it lessened the amount of disease when it was made early. On the other hand, when these compositions were used curatively, that is, when the disease had appeared, they had no material influence upon it. But as Dr. Voelcker remarks, it must be borne in mind that the season of 1892 was one in which disease was not by any means rife, and that when it appeared it was very late in the season: he adds "Seeing that the early

" dressing was most effectual where disease occurred the most, " it is a fair deduction that in a season when disease showed " itself badly, the dressing would give even more favourable " results than those now set forth."

The value of the treatment with bouillies of sulphate of copper is strikingly illustrated by the experiments carried on by the Technical Education Committee of the Wiltshire County Council, in which the average gain on the treated plots was equal to 2 tons 11 cwt. per acre.

In Messrs. Carters' trials at Bromley, bouillie bordelaise operated as a great preventive of disease, for out of 10 plots dressed in July and August six wholly escaped disease, and in the other four the amount of disease was infinitesimal, so that in a total yield of 22 cwt. 3 qrs. 26 lb. on these 10 plots, there were only $2\frac{3}{4}$ lbs of diseased tubers. Upon the untreated (control) 10 plots, in a yield of 14 cwt. 1 lb. there were 3 cwt. 1 qr. 11 lbs. of diseased potatoes.

With respect to the experiments made by the Agricultural Department of the Irish Land Commission it appears that there was disease present more or less in all the districts where the experiments were conducted. On all of the experimental plots that were not treated with sulphate of copper compositions disease showed itself in ratios of from 2·9 to 15·7 per cent. of the total yield of tubers.

On six of the plots treated with bouillie bordelaise there was absolutely no disease, and on the others the weight of diseased tubers ranged from ·03 to 11·0 per cent. of the entire crop.

Other experiments carried out in Ireland show that at the Albert Model Farm, Glasnevin, on four treated plots sown with a variety of potatoes (Kemp's) liable to disease, the average quantity of diseased tubers was 34·36 per cent., as against 60 per cent. upon an untreated plot. At the Munster Agricultural School the average quantity of diseased tubers in three sets of treated plots was 7·0 per cent., against 10·5 on untreated plots.

Of the foreign trials it may be remarked that Dr. Petermann's experiments in Belgium appear to demonstrate that treatment with bouillie bordelaise not only materially counteracts the injury from potato-disease, but that such treatment increases the yield, and materially increases the quantity of starch in the tubers.

M. Girard's investigations confirm the conclusions arrived at by Dr. Petermann. In his report on the experiments conducted in 1891, M. Girard points out that when a field is badly attacked by the disease the weight of the crop from the dressed plots is always greater than that from the untreated plots, but in the absence of disease, certain disease-resisting varieties of potatoes may yield a slightly diminished crop under the preventive treatment. Nevertheless, M. Girard observes that it is always advisable to apply the dressing, as it is never safe to assume that the disease will not make its appearance.

The interesting experiments made by Dr. Steglich at Dresden with six different varieties of potatoes treated with bouillie bordelaise exhibited an average increase in the value of the crop of all the varieties, amounting to 2*l.* 3*s.* 9*d.* per acre over and above the value of the crop of an acre not treated. In each case the cost of treatment, 13*s.* 8*d.* per acre, was deducted. And in another experiment, on a larger scale, by Dr. Steglich the net profit obtained by treatment with bouillie bordelaise amounted to 2*l.* 14*s.* 1*d.* per acre.

On the other hand, it will be observed that the experience of Dr. Liebscher of the Agricultural Institute attached to Göttingen University, shows that the dressings with bouillie bordelaise actually injured the foliage of healthy plants and reduced their yield by about 20 per cent. This is the most unfavourable testimony to the use of sulphate of copper composition for potato-disease that has yet been recorded. It is, it must be said, most difficult to understand how the comparatively weak solution of only 15 lbs. of sulphate of copper to 100 gallons of water, as used by Dr. Liebscher, could injure the plants in the manner described, seeing that much stronger solutions have been applied constantly without any injurious effect upon the leaves.

It should be borne in mind, however, that this unsatisfactory result was obtained in an exceptionally dry season, when the disease did not make its appearance at Göttingen. And Dr. Liebscher points out that although the dressing may injure the plants, it is much more injurious to the *phytophthora infestans*, so that in years in which the disease is prevalent the final results of the application of bouillie bordelaise may be represented by a favourable effect on the yield of the crop.

In his comments on Dr. Liebscher's unsuccessful experiment in 1892, Dr. Steglich remarks that, as there can be no doubt that the solutions used were properly prepared, it must be concluded that a very strong concentration of the copper, which may arise in consequence of excessive heat and absence of dew if the treatment is carried out on a particularly hot day or during the hottest part of the day, is injurious to the potato plants.

A review of the experiments carried out during the last few years indicates that the preventive treatment with bouillies of sulphate of copper has been employed with satisfactory results in most cases in seasons of disease, but the treatment has not an unbroken record of success. In seasons when the disease was absent the application of these dressings to potatoes has in a few cases appeared to have an injurious effect upon the yields of the crops.

On the whole, there is ample evidence to show that when the *phytophthora infestans* has once made its appearance the plants which have been previously treated with the bouillies offer more resistance to the attacks of the fungus than plants not so treated, and it would seem to be equally clear that when the

dressings are applied immediately after the plants exhibit signs of the affection they have the power of arresting the progress of the disease in a considerable degree.

The Composition of Bouillies.

Taking first the bouillie bordelaise sucrée, or bouillie with molasses, recommended by M. Girard as making the bouillie adhere to the leaves, the best mixture consists of—

20 lbs. of sulphate of copper,
20 lbs of lime, unslaked,
20 lbs. of molasses,
100 gallons of water.

The molasses is first mixed with water in a wooden tub, and the lime slaked in water is added to this. The sulphate of copper is dissolved in a separate wooden tub full of water, being first put in a bag of coarse sacking suspended over the side, the solution is then added to the lime and molasses. As Dr. Voelcker points out, an intense blue colour is obtained if the bouillie is properly prepared. If the molasses is put first and the sulphate of copper and lime added, sub-oxide of copper is formed, and the mixture becomes yellow and then red. It does not appear, however, from the various experiments recorded, that the bouillie bordelaise sucrée adheres better to the leaves than ordinary bouillie bordelaise, nor that it has any special advantage over this.

There have been several modifications in the manufacture of ordinary bouillie bordelaise. The original formula, and that adopted in the experiments of the Royal Agricultural Society was—

20 lbs. of sulphate of copper,
10 lbs. of lime,
100 gallons of water.

In 1892 M. Girard stated that it was better to use the same weight of lime as of sulphate of copper, and this prescription was adopted by Dr. Voelcker at Woburn, and by Messrs. Carter & Co. at Bromley, so that their formula was—

20 lbs. of sulphate of copper,
20 lbs of lime,
100 gallons of water.

The sulphate of copper was dissolved in the same manner as for the bouillie sucrée, and mixed with the lime solution, showing also a blue liquor, indicating that the whole of the copper had been precipitated.

Upon the question of the quantity of lime necessary to neutralize the acid and to cause a complete precipitation of the copper, much of course depends upon the purity of the lime. In the Irish experiments lime was used in the proportion of ½ lb.

to 1 lb. of sulphate of copper, and of ½ lb. of lime to 1 lb of sulphate of copper, it being found that the latter small proportion was quite sufficient if the lime was pure.

When the bouillie is mixed and diluted to the proper strength it may be conveyed to the potato field in a water-barrel from the tap of which the knapsack machines can be easily filled. For the horse machines it would have to be run into tubs from the water-barrel.

The quantity of solution used in the experiments varied from 100 to 220 gallons per acre, and depended probably to some extent upon the time of application and the quantity of foliage of the plants. Dr. Voelcker thinks that 120 gallons may be taken as a fair quantity for an average crop. And it may be considered that from 100 to 120 gallons is sufficient for a first dressing, and from 120 to 160 for a second dressing.

The machines used were the Éclair (knapsack), and Strawson's Antipest (knapsack). With these a man can dress from one-third to one-half an acre per day. A horse machine, invented by Mr. Strawson, has lately been much improved. By this the under side of the leaves can be well sprayed.

From five to seven acres can be sprayed in a day by this machine which takes one horse, and covers 78 rows at a time.

The cost of dressing, as given by the reporters in England, runs from 8*s.* 4*d.* to 9*s.* 10*d.* for one application. This depends upon the price of labour in the district, and the quantity of bouillie required. In Ireland the cost ranged from 7*s.* 8½*d.* to 9*s.* 1½*d.* per acre for each application.

The cost of dressing with bouillie sucrée amounts to 2*s.* or so per acre more.

Two applications were generally made; one towards the end of June, and another towards the end of July, especially where it was noticed that the sulphate of copper had been washed off.

Board of Agriculture,
4, Whitehall Place, S.W
September 1893.

PART I.

Experiments in Checking Potato Disease in Great Britain and Ireland.

REPORT ON THE EXPERIMENTS WITH BOUILLIE BORDELAISE, CARRIED ON IN 1892 BY THE ROYAL AGRICULTURAL SOCIETY OF ENGLAND FOR THE BOARD OF AGRICULTURE.

Experiments by the Royal Agricultural Society.

In their Report on Experiments for Checking Potato Disease, 1892 (C. 6647), the Board of Agriculture published the results of a series of trials with copper remedies for potato fungus carried out, on behalf of the Board, in the summer of 1891 in different parts of England and Wales by the Royal Agricultural Society of England.

The results of these experiments were of a valuable and practical nature; but in view of the conflicting experiences of investigations in the United Kingdom and elsewhere it was considered desirable that the experiments should be renewed in the following season. Early in 1892 the Board intimated to the Royal Agricultural Society their willingness to co-operate in a further series of experiments to be conducted in the summer of that year in accordance with a scheme drawn up by the Seeds and Plants Committee of the Society in the following terms:—

Scheme of Potato Experiments to be carried out by Royal Agricultural Society in 1892.

Scheme of Experiments.

Districts.—Six different localities to be chosen, five in England—viz., in the counties of Kent, Beds, Devon, Lincoln, and Cheshire, and one in (South) Wales.

Variety of Potato.—Wherever possible, experiments to be made on *one and the same* selected farm, with (*a*) an early variety of potato; (*b*) the main crop; (*c*) a late variety. If this should be impossible, the three crops to be selected on different farms in the same locality, as near to one another as possible. If it be impossible to obtain the three different crops in the same locality, the experiment must be confined to two crops, or even one.

Size and Number of Plots.—The minimum size of an experimental plot to be ¼ acre. The size recommended is ½ acre.

Experiments in Great Britain.

Experiments by the Royal Agricultural Society.

Each experiment on any one variety of potato to consist of three plots:—

Plot A.—For *early* application of the bouillie.
Plot B.—For *late* application of the bouillie.
Plot C.—To be left *untreated*.

Thus, if all three crops (early variety, main crop, late variety) are available on a farm, there should be nine plots in the experiment; if only two crops are available, then six plots; if only one crop, then three plots.

Arrangement with Experimenters.—The Society will undertake to pay the expenses of purchasing and forwarding sulphate of copper and lime, as also all reasonable expenses for labour of application of dressing, carriage hire, &c., but cannot undertake responsibility for any loss of crop.

Superintendence of Experiments.—The Society will provide for the necessary superintendence at the time when the bouillie bordelaise is applied to the potatoes, and also when the weighing of the crop takes place. The services of a farm labourer will be required at each experimental station for the actual application of the dressings under the direction of the superintendent.

The report of the Committee on the results of these experiments of 1892 was transmitted to the Board in the January of the following year and is reproduced below.

Experiments of 1892.

Report on Experiments of 1892.

In 1892 six different potato-growing localities were chosen, viz. in Kent, Bedfordshire, Lincolnshire, Cheshire, Devonshire, and South Wales, these being the same counties as were selected in 1891, but, with the exception of Messrs. Malden's farm in Bedfordshire, fresh districts were in each case chosen for the experiments of 1891–2.

The names of those who kindly undertook to carry out the experiments were:—

Mr. Thomas Scott, Ditton Court, Maidstone, Kent.
Messrs. Malden Bros., Cardington, Beds.
Mr. G. C. Healey, Deeping St. Nicholas, Spalding, Lincolnshire.
Lord Egerton of Tatton, Tatton Park, Knutsford, Cheshire.
Mr. W. P. Vosper, Merafield, Plympton, Devonshire.
Mr. Thomas Brown, Kingswood Farm, Pembroke Dock, S. Wales.

The superintendence of the experiments was entrusted to Mr. Henry Giles, whose services were most kindly lent to the Society by Mr. Garrett Taylor, of Norwich, though at considerable personal inconvenience. Mr. Giles visited each experimental station whenever necessary, and saw to the preparation of the bouillie bordelaise and its different applications to the crops, as well as to the final weighings of the produce. Mr. Giles's duties were discharged with the promptitude and careful attention which he has shown in the practical work of the experiments of the

Norfolk Chamber of Agriculture, and his management of the present series was in every way satisfactory. Mr. Carruthers, the Society's consulting botanist, examined the different samples of leaves which, according to instructions, were sent up from any of the stations at which disease was believed to have made its appearance. In addition, Mr. Carruthers devoted some ground by the side of his house to the carrying on of observations upon the progress of the disease and on the nature of the action of the bouillie bordelaise upon the parasitic fungus (*phytophthora infestans*) attacking the potato.

Experiments by the Royal Agricultural Society.

In 1891 only a single variety was experimented upon at each station, but the present series was considerably more extensive, and the endeavour was made to secure at each station not one crop only, but three different ones, representing respectively :—

Three varieties of potatoes.

(*a.*) An early variety of potato.
(*b.*) A medium variety.
(*c.*) A late variety.

At the same time it was felt not to be desirable to interfere with local considerations, and, accordingly, it was not laid down what particular varieties should be grown, but inquiries were made with a view of selecting those growers who would in the ordinary course have grown more than one kind of crop. Consequently, the varieties chosen were those which were in ordinary use in each locality.

It was further arranged to have in the case of each variety of potato three plots set aside for the experiment, as follows :—

Plot A for early application of the bouillie (before any disease appeared).

Plot B for late application of the bouillie (immediately upon disease making its appearance).

Plot C to be left untreated.

The maximum size of the plots was to be half an acre, the minimum size one-quarter acre, and they were to be divided off from the rest of the field, and from one another by small paths, so as to keep them distinct.

Composition of bouillie.

The composition and strength of the bouillie bordelaise mixture was the same as in the preceding year, viz :—

20 lb. sulphate of copper,
10 lb. lime (unslaked),
100 gallons water,

this being, accordingly, a two per-cent. strength solution of sulphate of copper. Particular care was taken to employ good and pure materials, more especially as some experiments conducted by other societies in the previous year were believed to have failed owing to the impurity of the materials used. The sulphate of copper was tested by Dr. Voelcker previous to the sending out of ½ cwt. kegs of it to each experimenter. Samples of the lime locally obtained and intended to be used were also sent to Dr. Voelcker, whose examination of them proved very necessary,

EXPERIMENTS IN GREAT BRITAIN.

Experiments by the Royal Agricultural Society.

as, in three cases out of the six, the samples first sent were unsuitable, they being either not properly burnt, or already slaked or otherwise impure. Ultimately, good lots were obtained at all the stations, though in some cases the lime had to come from other districts.

Machine used for distributing dressings.

The machine used for distribution of the bouillie was the "Éclair" machine of M. Vermorel, obtained from Messrs. Charles Clarke & Co., Windsor Chambers, 33, Great St. Helens, London, E.C. A slight lengthening of the tube carrying the nozzle for spraying was found desirable in order to distribute the dressing well on the underside of the leaves of the plant. The bouillie was made as before, by roughly pounding the sulphate of copper crystals,

Preparation of dressings.

placing them in a bag suspended in a wooden tub containing water, slaking the lime with water, and, when cool, pouring it, stirred up in water, into the sulphate of copper solution, a sieve being interposed to hold back any lumps, stones, &c., which might be in it and so tend to block up the spraying machine. By having the materials quite cool when mixed, and by keeping the liquid constantly stirred during the mixing, no difficulty was experienced in getting the bright-blue colour characteristic of properly made bouillie, as well as the rapid settling down of a whitish-blue deposit which left above it a quite clear, colourless liquid, containing no copper, the latter being entirely thrown down in the deposit.

Varieties of potatoes.

The different varieties of potato experimented on were :—

(*a.*) Early varieties	-	Beauty of Hebron (Kent and Pembroke).
		Myatt's (Lincolnshire).
(*b.*) Medium varieties	-	Snowdrop (Kent and Lincolnshire).
		White Elephant (Beds and Pembroke).
		Abundance (Cheshire).
(*c.*) Late varieties	-	Magnum Bonum (Kent. Lincolnshire, Devon).
		Imperator (Beds).
		Bruce (Devon and Cheshire).
		Irish Flounder (Pembroke).

The above distinctions are, of course, not absolute, a crop being considered "medium" in one district whilst it may be relatively "late" in another. Thus, the Magnum is considered a "medium" crop in Devon, relatively to the "later" crop Bruce, although it generally ranks as a "late" or "main" crop.

Period of application of dressing.

Profiting by the experience furnished last year, the intention was to apply the first or "early" application of the bouillie to the A plots about a fortnight before the time at which experience told the experimenters that the disease might be expected to appear on each crop.

Mr. Giles's visits were arranged in accordance with this plan, and inquiries were made from time to time as to the progress of of the crops and the likelihood of the appearing of disease.

In every case the A plots were sprayed well in advance of the outbreak of disease, and the B plots as soon after notification of the appearance of disease as was possible, Mr. Giles at once proceeding to the spot on receipt of telegraphic notice.

Experiments by the Royal Agricultural Society.

Two of the experimenters [Mr. Scott and Mr. J. T. Smith (for Lord Egerton)] varied the inquiry and increased its interest by dividing the A plots (early dressing) into two halves, giving one half a single application only of the dressing, and two applications to the other half. At Messrs. Malden's the A plots of the White Elephant were dressed once only, but the Imperator twice. At Mr. Healey's the A's were all dressed twice, but only once at Mr. Vosper's and at Mr. Brown's. In no case were the B plots (late application) dressed more than once, namely, on the appearance of disease.

Cost of application.

The cost of the application varied, of course, with the number of times it was put on, and the amount of foliage. For an early first dressing, from 100 to 120 gallons per acre were generally used, and 120 gallons for a second early application; for the B plots (late application) 120–140 gallons was the usual amount, but in one case (Mr. Healey's, Magnum), where the tops were very luxuriant, as much as 200 gallons was required. The sulphate of copper cost 18*s.* a cwt. and the lime about 10*s.* a ton, whilst the actual work of spraying may be put at 5*s.* per acre. A single application of 100 gallons per acre would accordingly cost about 3*s.* 4*d.* for material and 5*s.* for labour, altogether 8*s.* 4*d.*; one of 120 gallons 9*s.* altogether; one of 140 gallons 9*s.* 8*d.*, and a dressing, first of 100 gallons, and then another of 120 gallons, would cost 17*s.* 4*d.* per acre altogether. In the case of Mr. Vosper's (Devon) experiments, owing to a misunderstanding, the B plots (late application) were not dressed at all, and Mr. Giles, not having been informed of the appearance of disease, did not go there a second time. In one other instance, Mr. Giles did not dress the B plots (late application), namely, at Mr. Brown's, Pembroke Dock. Here no disease appeared at all on two of the three crops, and, thus, for the purposes of the inquiry the results might be omitted from consideration. As to the third variety, there was some uncertainty about the existence of disease, and Mr. Brown weighed the crops himself. The several experiments may now be treated of in their order. The particulars as to quantities applied, dates of application, &c., are given in the tables.

Gain in crop from dressing.

In comparing the gain in crop with the cost of dressing it will be seen that, taking the crop at about 55*s.* a ton all round, an increase of 4 cwt. per acre in crop would pay for a dressing costing 10*s.*, and an increase of 7 cwt. per acre for one costing 18*s.* an acre.

1. *Kent.—Mr. Thomas Scotts' Farm.*

Experiments in Kent.

Mr. Scott was anxious to try the difference between giving the crop one and two dressings, applied early, and this was

EXPERIMENTS IN GREAT BRITAIN.

Experiments by the Royal Agricultural Society.

accordingly done. Disease appeared on the Beauty of Hebron and Snowdrop before it did on the Magnum. It was less marked on the earlier than on the later dressed plots. The Magnum had particularly luxuriant haulms, and the tops of the A plots that had been twice dressed early remained growing after those on the other plots had died off.

The potatoes were weighed on September 28.

Beauty of Hebron.—From the results obtained it will be noticed that there was not entire prevention of disease, but a marked diminution in it by the early dressing, for, whereas the untreated plot had 29 per cent. of diseased tubers, there was only from 2 to 4 per cent. on the early-dressed plots. Together with this was an increase in crop of over 3 tons per acre, and the application consequently paid excellently. The plot singly dressed had rather more disease, but a somewhat increased crop. The late application seemed both to increase the crop and to lessen disease, but, while it paid well it was not so remunerative as the earlier dressing.

TABLE I.—KENT.

Dressings per Acre.	Sound Tubers per Acre.	Diseased Tubers per Acre.	Per-centage of Disease.	Increase of Crop per Acre, Sound Tubers.	Cost of Dressing per Acre.
BEAUTY OF HEBRON.					
A 100 gals., June 29	T. c. q. lb. 10 0 0 0	T. c. q. lb. 0 8 0 0	Per cent. 3·84	T. c. q. lb. 3 8 0 0	*s. d.* 8 4
Aa {100 „ „ „ 120 „ Aug. 4}	9 18 0 0	0 4 0 0	1·98	3 6 0 0	17 3
B 120 „ „ „	8 14 0 0	2 0 0 0	18·69	2 2 0 0	9 0
C ——	6 12 0 0	2 14 1 4	29·14	—	—
SNOWDROP.					
A 100 gals., June 29	9 18 2 8	0 16 0 0	7·45	3 7 3 20	8 4
Aa {100 „ „ „ 120 „ Aug. 4}	11 2 3 4	0 8 0 0	3·46	4 12 0 12	17 4
B 120 „ „ „	7 17 0 20	1 6 0 0	14·19	1 6 2 4	9 0
C ——	6 10 2 16	2 16 0 0	30·00	—	—
MAGNUM BONUM.					
A 120 gals., July 15	10 5 2 24	0 4 1 4	2·04	0 10 1 4	9 0
Aa {120 „ „ „ 120 „ Aug. 4}	11 16 0 0	—	None	2 0 2 8	18 0
B 120 „ „ 20	9 13 1 20	0 3 1 20	1·74	0 2 0 0 [decrease]	9 0
C ——	9 15 1 20	0 4 0 0	2·00	—	—

Plot A, early application; B, late application; C, untreated.

EXPERIMENTS IN GREAT BRITAIN.

Experiments by the Royal Agricultural Society.

Snowdrop.—Early applications lessened disease from 30 per cent. to 3·5 and 7·5 per cent., a largely increased crop also resulting. The advantage was with the double dressing. Late dressing also increased the crop, paying for the application, and it lowered disease from 30 per cent. to 14 per cent.

Magnum.—This crop had very little disease, and on the plot dressed twice before disease came there was entire absence of disease. There was some gain of crop, more than enough to pay the cost of application from the early dressings, the double dressing being the better. A small decrease of crop resulted from late application. Owing to the small extent to which disease prevailed, the influence of the dressing on prevention of disease is not marked.

Less disease and increase in crop from dressing.

The general result of Mr. Scott's experiments is to show a marked lessening of disease and also increase of crop from dressing the plots early, a double dressing before disease appeared being, on the whole, the best. The late applications had a less marked effect, though in the same direction, and there was only one case of loss through the applications, and that a very slight one.

2. *Bedford.—Messrs. Malden Brothers' Farm.*

Experiments in Bedford.

There was not much disease here. The crops were weighed September 21 (White Elephant), and November 8 (Imperator). With the White Elephant, an early dressing reduced disease from 5·5 per cent. to ·05 per cent., and gave also a paying increase of crop. A still larger gain of crop was obtained by the later dressing, but there was more disease. Both applications were effectual. With the Imperator a lessening of disease from 3·28 per cent. to ·80 per cent., together with large increase of crop, was obtained by the early dressing applied twice, but the later application showed neither lowering of disease nor gain of crop.

TABLE II.—BEDFORDSHIRE.

Dressings per Acre.	Sound Tubers per Acre.	Diseased Tubers per Acre.	Per-centage of Disease.	Increase of Crop per Acre, Sound Tubers.	Cost of Dressing per Acre.
	WHITE ELEPHANT.				
	T. c. q. lb.	T. c. q. lb.	per cent.	T. c. q. lb.	*s. d.*
A 120 gals., July 14 -	7 7 2 5	0 0 2 25	·05	0 19 0 4	9 0
B 135 „ Aug. 16 -	8 14 2 21	0 2 1 26	1·40	2 6 1 12	9 6
C ——	6 8 1 9	0 7 1 24	5·49	—	—
	IMPERATOR.				
A {120 gals., July 27 / 120 „ Sept. 5} -	12 6 0 0	0 2 0 0	·80	3 9 2 0	18 0
B 120 „ „ „ -	7 18 2 0	0 4 1 12	3·73	0 18 0 0 [decrease]	9 0
C ——	8 16 2 0	0 6 0 0	3·28	—	—

Plot A, early application; B, late application; C, untreated.

EXPERIMENTS IN GREAT BRITAIN.

Experiments by the Royal Agricultural Society.

The general result here is to show the efficacy of an early dressing, applied once or, if necessary, twice, both in lessening disease and in increasing crop.

3. *Lincolnshire.—Mr. G. C. Healey's Farm.*

Experiments in Lincolnshire.

Disease was but slight with the Myatt's Ashleaf, rather more with Snowdrop, and entirely absent in the case of the

TABLE III.—LINCOLNSHIRE.

Dressings per Acre.	Sound Tubers per Acre.	Diseased Tubers per Acre.	Per-centage of Disease.	Increase of Crop per Acre, Sound Tubers.	Cost of Dressing per Acre.
MYATT'S ASHLEAF.					
	T. c. q. lb.	T. c. q. lb.	Per cent.	T. c. q. lb.	*s. d.*
A { 90 gals., July 21 / 100 „ Aug. 6 } -	7 5 2 0	0 3 0 0	2·02	0 11 2 0	16 3
B 120 „ „ -	6 18 0 0	0 4 0 0	2·81	0 4 0 0	9 0
C ——	6 14 0 0	0 4 2 0	2·12	—	—
SNOWDROP.					
A { 120 gals., July 21 / 100 „ Aug. 6 } -	9 11 0 0	0 1 0 0	·52	2 17 0 0	17 3
B 120 „ „ -	7 14 0 0	0 6 0 0	3·75	1 0 0 0	9 0
C ——	6 14 0 0	0 13 0 0	9·40	—	—
MAGNUM BONUM.					
A { 90 gals., July 21 / 120 „ Aug. 6 } -	10 7 2 0	None	—	2 15 2 0	17 0
B 200 „ „ 21 -	8 8 0 0	„	—	0 16 0 0	16 8
C ——	7 12 0 0	„	—	—	—

Plot A, early application; B, late Application; C, untreated.

Results of early and late application.

Magnum. No lessening of disease occurred in the case of the Myatt's, but a slight increase of crop (which just covered the cost of application) was obtainable from both early and late dressings. With the Snowdrop, an early application reduced disease from 9·4 per cent. to ½ per cent. and largely increased the crop. The later application, though not so successful either in lessening disease or in increasing the crop, still paid well for using it.

In the case of the Magnum, as there was was no disease to check, the crop increases alone need be taken, the early application largely augmenting the yield, and the later one less so, but

Experiments by the Royal Agricultural Society.

still remuneratively. The large amount of dressing required on the B plots is noticeable, the tops having been very large. These results show that both early and late applications pay well, increasing the crop and reducing disease, the earlier dressing being the better in both respects.

4. *Cheshire.—Lord Egerton of Tatton's Home Farm.*

Experiments in Cheshire.

Mr. J. T. Smith, Lord Egerton's agent, wished also to try, in some cases, the relative influences of *once* and *twice* dressing the

TABLE IV.—CHESHIRE.

Dressings per Acre.	Sound Tubers per Acre.	Diseased Tubers per Acre.	Percentage of Disease.	Increase of Crop, sound Tubers, per Acre.	Cost of Dressing per Acre.
		ABUNDANCE.			
A 150 gals. July 8 -	T. c. q. lb. 10 14 0 24	T. c. q. lb. 1 5 0 0	Per cent. 10·45	T. c. q. lb. 2 9 3 4	*s. d.* 9 11
B 140 „ Aug. 26 -	9 18 0 16	0 18 2 24	8·61	1 13 2 24	9 7
C ——	8 4 1 20	1 2 3 12	12·20	—	—
		BRUCE.			
A 120 gals. July 8 - -	10 3 0 0	0 3 3 4	1·83	0 8 0 16 [decrease]	8 11
Aa { 120 „ „ - / 140 „ Aug. 26 - }	9 19 1 20	0 1 3 12	·92	0 11 2 24 [decrease]	18 7
B 140 „ „ -	10 17 2 16	0 1 1 4	·58	0 6 2 0	9 8
C ——	10 11 0 16	0 2 2 8	1·10	—	—
		MAIN CROP.			
A 110 gals. July 8 - -	8 16 2 16	0 0 1 4	·16	0 3 0 8 [decrease]	8 8
Aa { 110 „ „ - / 140 „ Aug. 26 - }	9 3 0 0	0 0 0 24	·11	0 3 1 4 [decrease]	18 3
B 140 „ „ -	8 5 1 12	0 0 1 12	·21	0 14 1 12	9 8
C ——	8 19 2 24	0 0 1 20	·23	—	—
		IMPERATOR.			
A 130 gals. July 8 -	10 13 3 12	3 5 0 16	23·34	1 19 2 16 [decrease]	9 4
Aa { 130 „ „ - / 140 „ Aug. 26 - }	11 6 2 24	2 16 0 0	19·80	1 6 3 4 [decrease]	19 0
B 140 „ „ -	13 4 0 0	1 7 2 24	9·50	0 18 2 0	9 8
C ——	12 13 2 0	1 19 1 4	13·41	—	—

Plot A, early application; B, late application; C, untreated.

EXPERIMENTS IN GREAT BRITAIN.

Experiments by the Royal Agricultural Society.

crop. Disease occurred to a certain extent in the Abundance and Imperator, but only very slightly in the Bruce and Main Crop. The potatoes were weighed October 5th and 6th.

Abundance.—Increase of crop, to a well-paying extent, resulted from both early and late applications, but the decrease of disease was less marked; the later dressing, however, was the more effectual in staying disease.

Bruce.—The influence of the dressings was here, in each case, to lessen the crop, nor was any result in lessening disease apparent.

Main Crop.—Here again, where disease was so slight, no preventive influence was shown from the dressings, and the crop was, in all cases but one, reduced slightly as well, the exception being with the plot twice dressed early, but where, however, the increase did not pay for the application.

Imperator.—Decrease of crop again was the result of the dressings, and there was even more disease on the early-treated plots than on the untreated plots. On the other hand, the late dressing seems to have lessened disease slightly and to have given a return that just paid for the application.

Use of dressing not satisfactory.

These results in Cheshire are somewhat anomalous, showing in one case (Imperator) an increase of disease from early dressing of the crop, and an increase of yield in the case of three varieties out of the four tried. The conclusion, therefore, is not satisfactory to the use of the dressing, be it early or late application, more especially the former. It was noted, however, that the soil varied considerably in texture on different parts of the field, and this not improbably had as much to do with the anomalous results as anything else.

5. *Devon.—Mr. Vosper's Farm.*

Experiments in Devon.

It had been intended to experiment on Early Puritan, but the crop had gone too far before the dressing could be put on, and so it was omitted. Unfortunately also, through Mr. Giles

TABLE V.—DEVON.

Dressings per Acre.	Sound Tubers per Acre.	Diseased Tubers per Acre.	Percentage of Disease.	Increase of Crop, sound Tubers, per Acre.	Cost of Dressing per Acre.
MAGNUM BONUM.					
	T. c. q. lb.	T. c. q. lb.	Per cent.	T. c. q. lb	*s. d.*
A 125 gals. July 22 -	8 13 1 24	0 7 2 0	4·14	2 3 1 24	9 2
C ———	6 10 0 0	0 19 0 0	12·75	—	—
BRUCE.					
A 125 gals. July 22 -	9 14 3 4	0 3 1 4	1·65	1 12 3 4	9 2
C ———	8 2 0 0	0 16 0 0	8·98	—	—

Plot A, early application; C, untreated.

Experiments by the Royal Agricultural Society.

not being informed of the occurrence of disease, the B plots (late application) were not dressed. Consequently the trial was confined to the efficacy of the early applications. There was a moderate amount of disease in the crops made use of. With Magnum, disease was reduced from 12·75 per cent. to 4 per cent., and, concurrently, a large gain of crop was obtained. With Bruce, disease was lessened from 9 per cent. to 1·65 per cent., and a considerable increase of crop was yielded also.

These results were distinctly favourable to the use of the early application.

6. *South Wales.—Mr. Thomas Brown's Farm.*

Experiments in South Wales.

As already stated, the trial plots were in two cases free from any disease, and had therefore no bearing on the question of the efficacy of the bouillie bordelaise in preventing or in checking disease. A decrease of crop was the result in one instance.

TABLE VI.—PEMBROKE.

Dressings per Acre.	Sound Tubers per Acre.	Diseased Tubers per Acre.	Per-centage of Disease.	Increase of Sound Tubers per Acre.	Cost of Dressing per Acre.
BEAUTY OF HEBRON.					
	T. c. q. lb.	T. c. q. lb.	Per cent.	C. q. lb.	*s. d.*
A 100 gals. June 18 -	4 1 2 0	—	—	4 3 0 [decrease]	8 4
C ——	4 6 1 0	—	—		—
WHITE ELEPHANT.					
A 100 gals. July 4 -	2 9 0 0	—	—	0 13 4 [decrease]	8 4
C ——	2 9 3 14	—	—		—
IRISH FLOUNDER.					
A 100 gals. June 18 -	6 8 1 16	0 17 2 16	12	12 3 2	8 4
C ——	5 15 2 14	1 4 3 26	17·67	—	—

Plot A, early application; C, untreated.

Crops singularly small.

The crops were singularly small, less than 2½ tons per acre of the White Elephant being raised, and only 4 tons per acre of Beauty of Hebron. It would hardly be satisfactory to consider these results conclusive. A somewhat larger crop was shown with the Irish Flounder, and though there was some doubt as to the actual appearance of disease, it was found, on raising the crop, that from 12 to 17½ per cent. were bad, and that where the dressing had been used (plot A) a larger crop of sound tubers was obtained and a less proportion of bad ones.

EXPERIMENTS IN GREAT BRITAIN.

CONCLUSIONS.

Experiments by the Royal Agricultural Society.

Putting together the results obtained from the different stations, excluding Cheshire, there is a unanimous verdict upon four points:—

Dressing checks disease.

1. That the dressing with bouillie bordelaise, though it does not entirely prevent disease, has a marked effect in lessening the extent to which disease spreads.

Crop increased.

2. That associated with the lessening of disease is an almost certain increase of crop, which more than pays for the cost of application of the dressing.

Early application best.

3. That the best treatment is an early application of the bouillie bordelaise before disease has made its appearance, and that this should be repeated if the marks of the first dressing have been removed by rain.

Late dressing checks spread of disease.

4. That, even if delayed until disease comes, a lessening of the spread of disease may to some degree be effected by a late dressing, and the crop, as a rule, will be sufficiently increased to pay for the application.

These results are borne out by four of the five stations at which the experiments were complete, those in Kent, Bedfordshire, Lincolnshire, and Devon exemplifying them almost in every particular, even with the many plots comprising the experiments at each spot. The results in Cheshire are the only ones that tell adversely to the utility of the dressing, and even here, in the case of one of the four crops, a large gain in yield was experienced.

General results of treatment favourable.

The general results may accordingly be stated as distinctly showing the advantage of using the bouillie bordelaise dressing, whether disease appears or not, and that the best plan is to apply the dressing about a fortnight before disease is likely to appear, and to renew it when washed off.

The foregoing Report on this year's experiments with bouillie bordelaise has been drawn up by Dr. Voelcker.

Mr. Carruther's experiment.

The following note is supplied by Mr. Carruthers on the experiments with potatoes conducted by him at Norwood:—

"The plot of ground on which the experiments were carried out had been in grass for many years; after it was trenched and well dunged, the potatoes were planted in the end of April. The seed tubers belonged to twelve varieties, and were planted in as many plots, each 16 feet by 8 feet, and containing 32 plants, so that every plant had 4 square feet to itself. There were consequently 384 seed potatoes planted, but of these seven failed to germinate.

The appearance of the plants above ground extended from May 19 to June 13. The earliest variety was the Early Regent, all the plants of it being visible by May 27. This was followed closely by the Magnum Bonum and the Abundance, and then the Bruce, the Holborn Prolific, and the Canon, all of which finished their germination within the fortnight. The Beauty of Hebron and the Holborn Reliance finished in the third week,

while the White Elephant, Carter's Surprise, Myatt's Ashleaf, and the Imperator extended into the fourth week.

Six of the potatoes were attacked shortly after germinating by a fungus which destroyed the tissues of the stem just above the ground, so that the leaves and the upper part of the stem fell to the earth and withered. The brown mycelium penetrated the cellular tissues, and spread itself over the surface of the stem at that part; portions of the stem were kept in a moist warm atmosphere, but although the mycelium continued to grow and spread over the glass, it produced no fructification, so that the species doing this injury could not be determined.

Experiments by the Royal Agricultural Society.

There was a vigorous growth of haulm above ground, but the soil in which they were planted, being stiff London clay, was very unfavourable for the proper development underground, and none of the tubers were fully ripened. No disease appeared in the plots. But, after the middle of August, some diseased haulms were spread among the potatoes. The only plot that was thereafter attacked by the fungus was Carter's Surprise. The leaves had already begun to lose their vigour, and the disease speedily completed the work of destruction, rendering it impossible to try the bouillie bordelaise. The plots which were still in vigorous growth were carefully watched, but no indications of disease were detected in the leaves above ground, nor in the potatoes when they were dug. It was proposed to treat the potatoes after they were attacked, and not to use the bouillie in these small plots as a preventive.

Careful observations were made twice daily of the temperature (maximum and minimum, wet and dry bulb), of the barometrical pressure, and of the rainfall, during the whole progress of the experiment. These observations had no importance, however, seeing that the disease did not appear in the plots."

(Signed) CHARLES WHITEHEAD,
Chairman of the Seeds and
Plant Diseases Committee.

6th December 1892.

EXPERIMENTS BY THE ROYAL AGRICULTURAL SOCIETY AT WOBURN ON PREVENTION AND CURE OF "POTATO-DISEASE."

Experiments at Woburn.

The Royal Agricultural Society, in addition to the experiments which it was conducting throughout the country on behalf of the Board of Agriculture, determined to institute others of its own, and the Woburn Sub-Committee drew up an extensive scheme for carrying out an inquiry at the Society's Experimental Farm at Woburn (Bedfordshire). The following report of the results of these experiments is reprinted from the Society's journal.

EXPERIMENTS IN GREAT BRITAIN

Experiments by the Royal Agricultural Society.

The soil at the Woburn Farm is a light sandy loam, very suitable for potato growing. The field chosen was that known as Lansome Field, on a portion of which field experiments have been in progress for some years, but which is unfortunately not sufficiently uniform all over to make it a good field for close scientific experiment. As, however, these trials were rather for comparative purposes, namely, to test the efficacy of the bouillie bordelaise mixture in preventing or in checking the spread of potato-disease, the known slight inequalities of the land were not of such material consequence, and though they had appeared in the course of experiments requiring close accuracy, they were not more than would be found in any ordinary field selected as suitable for an experiment such as proposed.

Plan of Experiment.

Bouillie bordelaise and bouillie bordelaise sucrée used.

It is desirable here to note the points of difference between the present experiments and those conducted by the Society in other parts of the country. In the first place, the dressings employed comprised not only the ordinary bouillie bordelaise, made up of sulphate of copper, freshly-burnt lime, and water, but also the kind known as bouillie bordelaise sucrée, which contains molasses in addition to the other ingredients. This was tried, inasmuch as some laboratory experiments made in France by M. Girard pointed to the mixture containing sugar as being more efficacious than the ordinary bouillie, the syrup probably helping to retain the copper salt more firmly on the leaves and thus rendering it less likely to be removed by heavy rain. The ordinary bouillie used was made up with double the quantity of lime used in the Society's other experiments, this composition being, however, one of those freely recommended in France; it had the advantage, too, of making the comparison between the inclusion and the omission of molasses more definite. The dressings employed were, accordingly:—

Mixture I. Bouillie Bordelaise.

20 lb. sulphate of copper.
20 „ lime (unslaked).
100 gallons water.

Mixture II. Bouillie Bordelaise Sucrée.

20 lb. sulphate of copper.
20 „ lime (unslaked).
20 „ molasses.
100 gallons water.

In addition, trials were made of two other methods of treatment which have been advocated. The first was, to steep the "seed" potatoes in a solution of sulphate of copper before planting them, as is often done in the case of seed-wheat. The second was, to

steep the seed-potatoes for twenty-four hours in a solution made up as follows :—

6 lb. sulphate of ammonia.
6 „ nitrate of potash.
25 gallons water.

Experiments by the Royal Agricultural Society.

A few small plots were devoted to these two-last-named experiments.

The general experiment with the bouillie bordelaise treatment was divided into two parts :—

(*a.*) A main experiment on three selected varieties of potato.

(*b.*) An experiment on a smaller scale with varieties specially susceptible to disease.

(*a.*) *The Main Experiment.*

The main experiment.

Three well-known varieties of potato, representing respectively an "early," a "medium," and a "late" crop, were chosen. These were Beauty of Hebron ("early"), Scotch Regents ("medium"), and Champions ("late"). Three plots, each one-quarter acre in size, were devoted to each variety, as follows :—

Plot A for early application of the dressing (before disease appeared).

Plot B for late application of the dressing (on appearance of disease).

Plot C to be left untreated.

The quarter-acre plots were sub-divided, and while on one-half the ordinary bouillie bordelaise was to be applied, the other half was to be dressed with the bouillie bordelaise sucrée, the C plots in either case remaining undressed. The plots of the first half (ordinary bouillie) will, for convenience, be designated plots Aa, Ba, Ca.

(*b.*) *Experiment on Special Varieties.*

Special varieties.

Smaller plots of $\frac{1}{16}$ acre each were set apart for trials with nine different varieties of potato which were believed to be specially liable to disease. Three plots, as before—one for early, one for late application of the dressing, and a third to be left untreated,—were marked out, the dressing consisting of the bouillie bordelaise sucrée.

The varieties selected were the following :—

Early kinds—Myatt's Ashleaf, Early Puritan, Early Rose.
Medium kinds—Dalmahoy, White Elephant, Reading Giant.
Late kinds—Imperator, Schoolmaster, Victoria.

The varieties chosen for the "steeping" experiment with sulphate of copper were Early Shaw and Village Blacksmith, and the same varieties also for the experiment with steeping in the sulphate of ammonia and nitrate of potash mixture. Each plot was $\frac{1}{32}$ acre in size.

Experiments by the Royal Agricultural Society.

Preparation of the Bouillie Bordelaise Mixtures.

Preparation of dressings.

In the preparation of the bouillie bordelaise sucrée certain precautions had to be observed, these being set out in M. Perret's recipe for making it. The molasses must first be mixed with water, and the freshly slaked lime and water added to it with constant stirring. The sulphate of copper solution must be separately prepared, and then be added to the lime and sugar mixture, the whole being kept vigorously stirred. A decomposition then sets in, resulting in the sucrate of lime (formed by the bringing together of the sugar and the lime) changing into sulphate of lime, and the sulphate of copper into sucrate of copper. An intense blue colour is thus obtained, and the mixture settles down into a whitish-blue deposit which contains all the copper, and a clear liquid above. If the molasses be added first to the copper solution and the lime be added afterwards, a reduction of the copper sulphate occurs, resulting in the formation of a suboxide of copper, the mixture acquiring a yellow and finally a red colour.

Bouillie bordelaise sucrée should be used fresh.

The bouillie bordelaise sucrée should be always used when freshly prepared, as, after standing for some time, it is apt to turn to a dirty-green colour, owing to slight reaction taking place.

It may be well to note here that the vessels employed in making either of the bouillie mixtures should be of wood and not of metal, as the latter would be quickly eaten into holes by the mixture, the composition of which would become modified. At Woburn two wooden tubs holding 10 or 12 gallons each were found very suitable for preparing the lime and sulphate of copper solutions and a 40-gallon paraffin cask for making the mixture in. The actual amount made each time was $33\frac{1}{3}$ gallons. Twenty gallons of water were stirred up in the large cask with $6\frac{2}{3}$ lbs. of molasses; $6\frac{2}{3}$ lbs. of quicklime were put in one of the small wooden tubs with $6\frac{2}{3}$ gallons of water and allowed to cool down, after which the milk of lime was added little by little to the molasses and water, the whole being kept stirred. In a second wooden tub $6\frac{2}{3}$ lbs. of pounded sulphate of copper were dissolved in a little boiling water, and, when dissolved, cold water was added, making the whole up to $6\frac{2}{3}$ gallons. The latter solution was then added little by little to the milk of lime and molasses mixture in the large cask, stirring being kept up vigorously all the time. This gave a bright blue liquor, made up as follows:—

	Lbs.			Gallons.
Molasses	$6\frac{2}{3}$	-	- with water	20
Lime	$6\frac{2}{3}$	-	- „ „	$6\frac{2}{3}$
Sulphate of copper	$6\frac{2}{3}$	-	- „ „	$6\frac{2}{3}$
	20			$33\frac{1}{3}$

this being the required strength of the bouillie bordelaise sucrée (Mixture II.).

In making up the ordinary bouillie bordelaise without sugar 6⅔ lbs. sulphate of copper were dissolved as before described, made up to 6⅔ gallons with cold water, and added little by little to 6⅔ lbs. of freshly-burnt lime slaked down with 26⅔ gallons of water and allowed to cool. This gave the necessary strength of the Mixture I.

Experiments by the Royal Agricultural Society.

In the steeping experiment with sulphate of copper, a solution of 2 per cent. strength sulphate of copper was used, and the whole tubers were immersed in it for 24 hours, then taken out and left to dry. In the other steeping experiment, whole tubers were put for 24 hours in a bath composed of 6 lbs. sulphate of ammonia, 5 lbs. nitrate of potash, and 25 gallons of water, after which they were taken out and left for another 24 hours to swell, being then planted whole. This latter method is said to have resulted in producing in France a crop of 42 tons per acre.

Steeping experiment.

The sulphate of copper was tested before using, and was found to be pure, but considerable difficulty was experienced in getting good lime locally, so that, ultimately, burnt lime had to be obtained from Buxton.

Application of the Dressing.

Application of dressing.

Mr. Elliott, the Superintendent of the Woburn Experimental Farm, paid a good deal of attention to the best way of applying the dressings, the quantities required, and the permanence of the application, and he has furnised useful notes on the several points. His method of procedure was,—after having prepared the 33⅓ gallons of mixture in the 40-gallon cask, as mentioned in the last section—to put the cask on a cart and convey it to the potato field. The contents were stirred up (otherwise the deposit would settle down at the bottom) and baled out into the spraying machine. The machine used was the "Éclair" of M. Vermorel. This machine was found to work very effectually. Mr. Elliott thinks that a better plan than baling out the mixture would be to have a large wooden tap at the bottom of the cask and to fill the "Éclair" from it. He considers the work of applying the dressing rather heavy, the weight alone of the machine when full being considerable. A slight increase of the daily wage paid to the men was made, and this got over any difficulty. The man who applies the dressings should be provided with an old suit of clothes, as it is impossible to keep the spray away from the person using the machine.

Under side of leaf sprayed.

Particular instructions were given that the spraying should be done as thoroughly as possible on the *under side* of the leaf. As Mr. Carruthers, the Society's Consulting Botanist, has pointed out, it is on the *under side* of the leaf that the potato is attacked by the spores of the fungus (*phytophthora infestans*) settling on it and forcing its roots or *hyphæ*, as they are scientifically termed, into the *stomata* or openings which occur on the *under side* of the leaves, but far less numerously on the upper surface. On the upper surface, moreover, the leaf is provided with closely-set palisade cells which resist the entry of the *hyphæ* of the fungus,

Experiments in Great Britain.

Experiments by the Royal Agricultural Society.

whereas these cells do not exist on the under side of the leaf. This view of the reasons that make it desirable to spray the under side especially is disputed by some practical men, including M. Vermorel himself, who maintains that effective spraying of the upper side of the leaves is ample, and that sufficient of the mixture finds its way below. But the botanical point involved is not questioned, and hence it seems sound reason and practice to guard the *lower* surface particularly, more especially as, in doing this, the operator cannot well fail to give a copious dressing to the upper surface at the same time. This, no doubt, involves the use of a larger quantity of the mixture, but it is the safer practice. With care it was found quite practicable to direct the nozzle of the machine under the leaves and, turning it upwards, to spray the under side of the leaves effectually.

Quantity of solution applied.

Mr. Elliott found that when the tops of the plant were still small, one man working with an "Éclair" could spray half-an-acre of potatoes per day, but that when the tops became larger, not above one-third of an acre a day could be done, and that when the tops grew very large it was impossible to spray each plant effectually without using a great amount of the dressing, as much as 200 gallons to the acre being occasionally required It was found in general that the quantity used varied from 100 gallons to 170 gallons per acre, according to the size of the tops. For a first dressing 100 gallons was enough, and for an average crop 120 gallons per acre might be taken as a fair quantity.

The weather best suited to the application was found to be a good drying day with moderate breeze; the dressing then dried on the leaves at once, and when this was the case it seemed to stick on them much longer than when put on upon a dull damp day. Mr. Elliott watched the dressed leaves carefully and noted that the effect of the spraying could be found on the under side of the leaves quite six weeks after its application, although all trace of it had been washed off the upper surface of the leaves.

Cost of Dressing.

Cost of dressing.

The raw materials were purchased as follows: Sulphate of copper (in half-cwt. lots in small wooden kegs), 18*s.* per cwt.; burnt lime (when purchased at a distance), 10*s.* per ton; molasses (purchased locally), about 1½*d.* per lb. A small addition must be made for carriage, but, taking it all round, it may be said that the general cost of the materials used in the two mixtures of bouillie were:—

	I. Bouillie Bordelaise.	II. Bouillie Bordelaise Sucrée.
	s. d.	*s. d.*
For 100 gallons per acre - - -	3 6	6 0
„ 120 „ „ - - -	4 2	7 2
„ 140 „ „ - - -	4 10	8 4

Experiments by the Royal Agricultural Society.

To the prices of materials must be added the cost of the actual application. This Mr. Elliott estimated at from 4*s.* to 6*s.* an acre. Taking 5*s.* an acre as the average, this would give the total cost of using the dressing:

	I. Bouillie Bordelaise.	II. Bouillie Bordelaise Sucrée.
	s. d.	*s. d.*
For 100 gallons per acre - - -	8 6	11 0
„ 120 „ „ - - -	9 2	12 2
„ 140 „ „ - - -	9 10	13 4

Sale of produce.

The last valuation necessary to make is that of the produce, which is very difficult to fix even approximately, as so much depends upon the state of the market. This year, indeed, owing to the small prevalence of disease, potatoes in Bedfordshire were almost a drug in the market, and very great difficulty was experienced in getting rid of them at almost any price. The price would vary also for each kind of potato. From 45*s.* to 90*s.* per ton (of 40 bushels) were the variations, and it could not be said that, as regards the really saleable potatoes, taking them all round, a higher price than 55*s.* a ton on the farm could be put. As to the others, a good number had to be sold as "cattle" or "pig" potatoes, and did not realise more than 25*s.* or 30*s.* a ton.

Planting.

Planting.

The field was ridged up well and dunged all over with about twenty loads of yard manure to the acre previous to the potatoes being put in; the tubers were set on the dung, and the ridges were split back. All the different varieties were set from April 15 to April 26, the early varieties first, and a nice steady rain succeeded the planting. The plants were bouted up June 10 to June 14. A severe frost on June 14 affected to some extent the young growth of the "earlies." On the plots (Early Shaw and Village Blacksmith) where the tubers had been steeped in sulphate of copper or in the solution of sulphate of ammonia and nitrate of potash, only a stray plant appeared, the dressings having evidently destroyed the vitality of the tubers, for, on the corresponding untreated plots of both varieties, the crop came up well.

Dates of Application of Dressing and Appearance of Disease.

Dates of application.

The first dressing with bouillie was done on 30th June, the earlier kinds having grown sufficiently by then; the other varieties were dressed for the first time on 6th and 7th July, and the whole was finished before any sign of disease appeared.

Experiments by the Royal Agricultural Society.

The plants grew on, and by the middle of August the "early" kinds were quite ready to take up, but still no disease came, so these crops, viz., Beauty of Hebron, Myatt's Ashleaf, Early Rose, and Early Puritan, were raised 10th to 13th August, as also the Dalmahoy of the "medium" varieties on 16th August. There were no diseased tubers in either of these crops. On 24th August it was noticed that the dressing had for the most part been washed off the leaves of the remaining plots, and directions were given that the plants should be again sprayed. This was begun on 1st September, and the very same day (and before the spraying could be completed) disease began to make its appearance. Mr. Carruthers's examination of some of the leaves sent to him confirmed the presence of the fungus (*phytophthora infestans*). The varieties most affected appeared to be Schoolmaster, Victoria, and White Elephant. Thereupon not only were the previously dressed A plots (for early application) sprayed once more, but the B plots (for late application) were also treated. By 9th September all the A and B plots had been dressed. Bearing in mind that the A plots were those dressed early, before disease appeared, that the B plots were dressed late, on the appearance of disease, and that the C plots remained untreated throughout, the following notes, taken on 3rd September, may be given :—

Appearance of disease.

White Elephant	-	A hardly attacked at all. B very badly diseased. C very badly diseased.

Here a marked difference was seen between the A plot and the others.

Reading Giant	-	A and B hardly touched. C one large patch in centre of plot diseased.
Imperator -	-	A and C leaves slightly spotted. B rather more attacked.
Schoolmaster -	-	All plots slightly attacked; A less than the others.
Victoria -	-	All plots slightly attacked; A less than the others.
Regent -	-	All plots slightly spotted; no difference between them.
Champion -	-	Hardly attacked at all; only a few spots here and there; no difference between the plots.

Condition of plots.

Thus it will be seen that, while the A plots were, generally speaking, rather less attacked than the B and C plots, there was only one instance, the White Elephant, where there was a marked difference in favour of the A's. This, however, it should be noted, was where disease was most prevalent. After 3rd September the disease became much worse on all the plots. As the

crop approached ripeness, a considerable difference was noted between the tops which had been sprayed (A and B) and those which had not been dressed. The tops of the sprayed plots remained green long after the haulms on the C plots had died down. All the remaining crops were dug and weighed 11th to 25th October.

Notes on the Varieties.

Notes on varieties.

The following notes were taken by Mr. Elliott upon the relative qualities of the different varieties :—

Beauty of Hebron -	Good early cropper; clean skin; shallow eye; very saleable.
Myatt's Ashleaf -	An early kidney potato; small cropper and hardly a field variety; the skin becomes scabby on the Woburn land.
Early Puritan -	Early and fair cropper, but runs rather small.
Early Rose - -	Early, but not very saleable, as it is very apt to grow pink right through the tuber.
Dalmahoy - -	Medium early; good cropper; not a coarse skin, but rather scabby.
Regent - -	Coarse-skinned; deep-eyed; very unsaleable.
White Elephant -	Good cropper (although liable to disease); cooks well; saleable, but does not keep well.
Reading Giant -	Good-looking potato; very heavy cropper, clean thin skin; saleable.
Champion - -	Coarse cattle potato; deep-eyed; goes hollow in centre and becomes rotten there; almost unsaleable.
Imperator - -	Very good cropper; clean skin; plant has very large tops; quite saleable.
Schoolmaster - -	Very fair cropper, but scabby, and not a saleable potato.
Victoria - -	Average cropper; good cooker; apt to grow out of ground instead of pushing downwards.

From these notes, and the crop weights that follow, it will be gathered that the best potato among the "earlies" was the Beauty of Hebron, among the "medium" crops the Reading Giant, and of the "late" varieties the Imperator.

The potatoes when dug were divided into sound and diseased tubers, which were weighed separately. The weights per acre of the respective varieties are given in the accompanying tables, which also show the influence of the early and late applications of the bouillie dressing.

EXPERIMENTS IN GREAT BRITAIN.

Experiments by the Royal Agricultural Society.

Steeping tubers quite unsuccessful.

Before proceeding to discuss the tables, the experiments in steeping the tubers before planting may be dismissed briefly by saying that they were quite unsuccessful. With regard to steeping in sulphate of copper, it was pretty well known to the scientific officers of the Society that it would most probably result in destroying the vitality of the tubers, but the trial was made in consequence of a suggestion that if steeping seed-wheat in sulphate of copper prevented "smut," the disease in the potato-crop might be similarly prevented. But the two cases are by no means analogous, for, with the wheat, the fungus is associated with unhealthy seed, and is on the exterior of the seed, subsequently penetrating into it; whereas the fungus of potato-disease arises from sources *external* to the plant and may be carried to the leaves of perfectly healthy plants. Again, while the germ of the wheat is protected by the hard casing of the seed, the potato tuber has only a delicate skin which is not sufficient to prevent the known destructive action possessed by a solution of sulphate of copper.

The steeping in a solution of sulphate of ammonia and nitrate of potash similarly destroyed the vitality, and fell very far short of producing the stated 42 tons per acre.

In connection with these steeping experiments it is well to mention that in a trial on potatoes carried out at Lord Egerton of Tatton's Home Farm, these two same methods were employed, and with precisely similar results to those obtained at Woburn.

THE RESULTS.

Results of dressings on disease.

It now remains to discuss the results of the weighings, with a view of ascertaining the following principal points:—

1. Whether the application of the bouillie had a *preventive* effect.

2. Whether the application had a *curative* effect when disease had once appeared.

3. Whether the mixture *with* sugar or that *without* sugar was the more effectual.

4. Whether the application of the dressings had any influence in increasing or diminishing the produce.

5. Whether, on the whole, it *paid* to use either dressing.

It is advisable to consider the cases in which no disease whatever occurred separately from the others. These cases include all the "early" varieties, and one "medium" variety (Dalmahoy). In these the influence of the dressings in preventing or checking disease is of course not apparent, and, generally speaking, it may be said of "early" potatoes that they are, as a rule, out of the ground before disease appears. It remains only, therefore, to follow the influence on the yield.

Series 1. Beauty of Hebron.—It is very clear from the figures that the part of the field where the plots 1 A, 1 B dressed with the bouillie bordelaise sucrée occurred (for they were together at at one end and the comparative ones dressed with the ordinary

bouillie without sugar were at the other end) is poorer than the end where plots 1 Aa, 1 Ba were. The addition of sugar to the mixture showed no gain as compared with its omission. The dressing in each case showed a decrease of crop, the greater decrease being when the early application was used.

Experiments by the Royal Agricultural Society.

Series 4. *Myatt's Ashleaf.*—A gain of crop was obtained by the early dressing, but not quite enough to pay for the application. With the late dressing there was a slight loss.

Series 5. *Early Puritan.*—Here there was a distinctly paying gain, more especially from the early application.

Series 6. *Early Rose.*—The result was similar to the last, but the gain was a much-increased one.

Series 7. *Dalmahoy.*—Again a very large increase of crop, and, as before, more marked with the earlier application.

On the whole, therefore, there is a gain of crop with four varieties out of five, the result being a paying one in three cases, while in a fourth the cost is just about met. With one variety only (Beauty of Hebron) was there a decrease.

General result favourable, early application more beneficial.

The general result of the dressing, even when disease has not appeared, is favourable to the adoption of the remedy, and goes to show that the early application is decidedly the more beneficial, while the addition of sugar to the mixture would not appear to be an advantage, but only an increased expense.

Taking next the cases where disease appeared:—

Series 2. *Regent.*—There was a considerable amount of disease here. The application, whether of the ordinary bouillie bordelaise or of the same with sugar, had a marked influence in decreasing disease. Nevertheless, it did not succeed in preventing it altogether. When dressed early, disease was lessened in the one case by 10 per cent. and in the other by 7 per cent. The addition of sugar proved of no advantage in lessening disease, but (somewhat inconsistently, it must be said) the crop was largely increased, and paid excellently for the application. The heaviest crop, however, was not more than when no sugar was used.

Series 8. *White Elephant.*—Here again was a good deal of disease. The early application of the mixture decreased disease very largely, though it did not prevent its appearance; the reduction was one from 26 per cent. down to 8 per cent. The late application was of only slight benefit, and evidently did not "cure" the disease when once it had appeared. As to the weight of crop, a slight decrease was shown with the earlier dressing, and a considerable one with the later.

Series 9. *Reading Giant.*—This was a remarkably heavy crop, the heaviest of all the series, amounting in each plot to over 15 tons per acre. Disease was very slight, and there was a small increase of crop when either dressing was applied, which just paid for the cost.

TABLE I.—*Early Crops.*

Variety.	Plot.	Weight per Acre of Sound Tubers.	Weight per Acre of Diseased Tubers.	Per cent. of Diseased Tubers.	Increase of Crop per Acre.	Decrease of Crop per Acre.	Per-centage of Increase in Crop.	Per-centage of Decrease in Crop.	Cost of Dressing per Acre.	Value of Gain or Loss in Crop per Acre by the dressing.	Nett Profit or Loss per Acre by the dressing.
		T. c. q. lb.	T. c. q. lb.	Per cent.	T. c. q. lb.	T. c. q. lb.	Per cent.	Per cent.	*s. d.*	*s. d.*	*s. d.*
Beauty of Hebron -	1 Aa	6 11 1 20	None	None	—	1 13 0 14	—	20·13	18 4	− 91 0	− 109 4
„ „ -	1 Ba	8 0 0 0	„	„	—	0 4 2 6	—	2·76	9 2	− 12 4	− 21 6
„ „ -	1 Ca	8 4 2 6	„	„	—	—	—	—	—	—	—
„ „ -	1 A	5 16 0 0	„	„	—	1 8 1 20	—	19·68	24 4	− 78 4	− 102 8
„ „ -	1 B	6 1 0 8	„	„	—	1 3 1 12	—	16·17	12 2	− 63 11	− 76 1
„ „ -	1 C	7 4 1 20	„	„	—	—	—	—	—	—	—
Myatt's Ashleaf - -	4 A	5 8 3 12	„	„	0 7 2 24	—	7·62	—	24 4	+ 20 7	− 3 9
„ „ -	4 B	5 0 1 4	„	„	—	0 0 3 12	—	·84	12 2	− 2 0	− 14 2
„ „ -	4 C	5 1 0 16	„	„	—	—	—	—	—	—	—
Early Puritan - -	5 A	6 17 1 4	„	„	1 3 0 0	—	20·12	—	24 2	+ 63 3	+ 39 1
„ „ -	5 B	6 5 0 0	„	„	0 10 2 24	—	9·37	—	12 2	+ 28 10	+ 16 8
„ „ -	5 C	5 14 1 4	„	„	—	—	—	—	—	—	—
Early Rose - -	6 A	6 16 2 8	„	„	1 12 3 12	—	31·68	—	24 2	+ 90 0	+ 65 10
„ - -	6 B	6 5 0 0	„	„	1 1 1 4	—	20·52	—	12 2	+ 58 5	+ 46 3
„ - -	6 C	5 3 2 24	„	„	—	—	—	—	—	—	—
Dalmahoy - -	7 A	9 7 0 0	„	„	1 16 0 16	—	23·95	—	24 2	+ 99 0	+ 74 10
„ - -	7 B	8 6 2 8	„	„	0 15 2 24	—	10·41	—	12 2	+ 42 7	+ 30 5
„ - -	7 C	7 10 3 12	„	„	—	—	—	—	—	—	—

Plots A dressed twice, before disease appeared, with bouillie bordelaise sucrée.
Plots B dressed once, upon appearance of disease, with bouillie bordelaise sucrée.
Plots C left untreated.

Plots Aa, Ba, dressed with the ordinary bouillie bordelaise without sugar.
Plots Ca, left untreated, to compare with Aa and Ba.

TABLE II.—*Medium Crops.*

Variety.	Plot.	Weight per Acre of Sound Tubers.	Weight per Acre of Diseased Tubers.	Per cent. of Diseased Tubers.	Increase of Crop per Acre.	Decrease of Crop per Acre.	Per-centage of Increase in Crop.	Per-centage of Decrease in Crop.	Cost of Dressing per Acre.	Value of Gain or Loss in Crop per Acre by the dressing.	Nett Profit or Loss per Acre by the dressing.
		T. c. q. lb.	T. c. q. lb.	Per cent.	T. c. q. lb.	T. c. q. lb.	Per cent.	Per cent.	*s. d.*	*s. d.*	*s. d.*
Scotch Regent -	2 Aa	9 16 2 8	0 13 0 0	6·23	—	0 15 2 24	—	7·40	18 4	– 43 3	– 61 7
„ „ - -	2 Ba	9 12 0 0	0 19 12 16	9·28	—	1 0 1 4	—	9·59	9 2	– 55 8	– 64 10
„ „ - -	2 Ca	10 12 1 4	2 1 0 0	16·18	—	—	—	—	—	—	—
„ „ - -	2 A	9 3 2 24	0 17 1 4	8·59	2 1 2 8	—	29·24	—	24 4	+ 114 1	+ 89 9
„ „ - -	2 B	8 3 2 0	1 6 1 4	13·85	1 1 1 12	—	15·02	—	12 2	+ 58 5	+ 46 3
„ „ - -	2 C	7 2 0 16	1 6 1 4	15·60	—	—	—	—	—	—	—
White Elephant -	8 A	9 12 2 8	0 17 1 20	8·29	—	0 5 0 0	—	2·53	24 2	– 13 9	– 37 11
„ „ - -	8 B	9 8 0 0	2 16 0 0	25·00	—	1 9 2 8	—	14·92	12 2	– 81 1	– 93 3
„ „ - -	8 C	9 17 2 8	3 12 0 0	26·70	—	—	—	—	—	—	—
Reading Giant -	9 A	15 11 1 20	0 5 0 0	1·56	0 8 3 12	—	2·92	—	24 2	+ 24 0	– 0 2
„ „ - -	9 B	15 8 3 12	0 2 2 8	·82	0 6 1 4	—	2·07	—	12 2	+ 17 2	+ 5 0
„ „ -	9 C	15 2 2 8	0 6 0 24	2·01	—	—	—	—	—	—	—

Plots A dressed twice, before disease appeared, with bouillie bordelaise sucrée.
Plots B dressed once, upon appearance of disease, with bouillie bordelaise sucrée.
Plots C left untreated.

Plots Aa, Ba, dressed with the ordinary bouillie bordelaise without sugar.
Plots Ca, left untreated, to compare with Aa and Ba.

TABLE III.—*Late Crops.*

Variety.	Plot.	Weight per Acre of Sound Tubers.	Weight per Acre of Diseased Tubers.	Per cent. of Diseased Tubers.	Increase of Crop per Acre.	Decrease of Crop per Acre.	Per-centage of Increase in Crop.	Per-centage of Decrease in Crop.	Cost of Dressing per Acre.	Value of Gain or Loss in Crop per Acre by the dressing.	Nett Profit or Loss per Acre by the dressing.
		T. c. q. lb.	T. c. q. lb.	Per cent.	T. c. q. lb.	T. c. q. lb.	Per cent.	Per cent.	*s.* *d.*	*s.* *d.*	*s.* *d.*
Champion	3 Aa	12 19 2 8	0 2 0 16	·81	—	1 2 3 12	—	8·09	18 4	— 62 6	— 80 10
„	3 Ba	14 11 0 8	0 2 0 24	·75	0 8 12 16	—	3·94	—	9 2	+ 23 4	+ 14 2
„	3 Ca	14 2 1 20	0 2 1 20	·85	—	—	—	—	—	—	—
„	3 A	10 14 0 3	0 2 2 0	1·15	—	1 12 3 12	—	13·31	24 4	— 90 0	— 114 4
„	3 B	11 19 0 0	0 1 1 12	·80	—	0 7 3 12	—	3·18	12 2	— 21 3	— 33 5
„	3 C	12 6 3 12	0 2 2 8	1·03	—	—	—	—	—	—	—
Imperator	10 A	13 0 1 4	0 10 2 24	3·95	0 14 2 8	—	5·93	—	24 2	+ 39 10	+ 15 8
„	10 B	13 5 2 8	0 7 2 24	2.82	0 19 3 12	—	8·08	—	12 2	+ 54 3	+ 42 1
„	10 C	12 5 2 24	0 7 2 8	2·98	—	—	—	—	—	—	—
Schoolmaster	11 A	8 12 2 8	0 2 0 16	1·22	—	2 0 1 4	—	18·92	24 2	— 110 8	— 134 10
„	11 B	9 13 0 0	0 5 0 16	2·59	—	0 19 3 12	—	9·32	12 2	— 54 3	— 66 5
„	11 C	10 12 3 12	0 6 0 16	2·81	—	—	—	—	—	—	—
Victoria	12 A	10 2 0 0	0 5 1 20	2·61	2 17 0 16	—	39·44	—	24 2	+ 156 9	+ 132 7
„	12 B	8 14 2 8	0 14 1 20	7·63	1 9 2 24	—	20·51	—	12 2	+ 81 1	+ 69 1
„	12 C	7 4 3 12	0 15 2 8	9·70	—	—	—	—	—	—	—

Plots A dressed twice, before disease appeared, with bouillie bordelaise sucrée.
Plots B dressed once, upon appearance of disease, with bouillie bordelaise sucrée.
Plots C left untreated,

Plots Aa, Ba, dressed with the ordinary boullie bordelaise without sugar.
Plots Ca, left untreated to compare with Aa and Ba.

The foregoing comprise the "medium" varieties. Coming next to the "late" varieties:— EXPERIMENT IN GREAT BRITAIN.

Series 3. *Champion.*—There was hardly any disease at all, but the dressings, except in one case, lessened the crop. The sugar admixture was not more beneficial than the other. Experiments by the Royal Agricultural Society.

Series 10. *Imperator.*—Disease occurred, but only to a small extent. The dressings did not lessen disease, but in each case increased the crop well above the cost incurred. The balance was in favour of the later application.

Series 11. *Schoolmaster.*—There was only a little disease, which was slightly lessened by the early application. The crop was, however, decidedly heavier on the untreated plot.

Series 12. *Victoria.*—Here disease occurred, and the dressings succeeded in lessening it, more especially the early dressing, there being only 2·6 per cent. of disease, as against 9·7 per cent. on the untreated plot. The crop also showed a remarkable increase where the dressings were put on, the early one being very successful indeed.

With the "medium" and "late crops" it would appear that the dressings, though successful in reducing the amount of disease wherever it occurred to any marked extent (viz., in Regent, White Elephant, and Victoria), did not in any case prevent it altogether. The early application was decidedly more successful than the later one. There was no case in which the sugar admixture was more efficacious than that without it. As to gain or loss of crop, out of seven cases, there are three of loss and three of gain, while in the seventh (Regent) gains and losses are balanced. There is only one clear case in which the late dressing has done any *marked* good. With medium and late crops dressing did not prevent disease altogether.

Taking all the varieties, "early," "medium," and "late," together, there are, as the result of the dressings, good paying gains of produce in five cases out of twelve, as against four cases of loss, and three cases where gains and losses about balanced. Further, out of seven cases in which disease occurred, the dressings succeeded in five instances in reducing the amount of disease, while in no case was it increased.

CONCLUSIONS.

To sum up these results, the following conclusions may be drawn:— Conclusions.

1. That neither the ordinary bouillie bordelaise, nor the bouillie bordelaise sucrée, had an entirely *preventive* effect, though both of them, when applied early and before disease appeared, succeeded in lessening the extent to which disease proceeded. Dressings not entirely preventive.

2. That neither dressing when applied after disease appeared had any material effect in *curing* the disease. Do not cure disease.

EXPERIMENTS IN GREAT BRITAIN.

3. That the addition of sugar to the ordinary bouillie bordelaise did not constitute any advantage, but only added to the expense.

Experiments by the Royal Agricultural Society,

4. That the effect of either dressing upon the weight of produce was uncertain, but tended in the majority of cases to increase rather than to diminish the crop.

Early application recommended.

5. That, in view of the lessening of disease, and the increase, in the majority of cases, of the crop, the early application of the ordinary bouillie bordelaise is to be recommended as a remunerative one.

It must be borne in mind that the past season was one in which disease was not by any means prevalent, and that disease appeared very late in the year. Seeing that the early dressing was most effectual where disease occurred the most, it is a fair deduction that in a season when disease showed itself badly the dressing would give even more favourable results than those now set forth.

(Signed) J. AUGUSTUS VOELCKER.

EXPERIMENTS BY THE TECHNICAL EDUCATION COMMITTEE OF THE WILTS COUNTY COUNCIL.

Experiments by Wilts County Council.

In 1892 some experiments with potato dressings were carried out by the Technical Education Committee of the Wilts County Council at Warminster, Horningsham, and Heytesbury, and the following summary of the results of these experiments has been compiled from the Report of the Committee which was published early in 1893.

In the report of the Hon. Secretary to the Experiment Sub-Committee it is stated that in addition to the dressings applied on the experimental plots, it was thought desirable, in order to secure a greater range of varieties and situations, and also to secure results on larger areas, to apply the dressings on other and, in some cases, larger plots than those of the experimental stations. Eight plots of potatoes were therefore selected for trial in the neighbourhood, whose owners were willing to apply the dressing, and which were apparently suitable in respect of situation and uniformity. In all cases, both on the experimental plots and on the eight plots above mentioned, equal areas were left undressed adjoining those which were dressed.

Perret's modification of bouillie bordelaise used.

The dressing used was that known as Perret's modification of the original "Bouillie Bordelaise," and was made in the proportion of 2 lbs. each sulphate of copper, lime, and molasses, to 10 gallons of water. It was distributed from a Vermorel's "Éclair" spraying machine, which is carried as a knapsack, and holds three gallons.

Experiments at Warminster.

At Warminster the first dressing of the sucrated copper and lime mixture was applied on July 21st during fine weather, which

Experiments by Wilts County Council.

continued for a fortnight afterwards. The quantity used was about one gallon per perch = 160 gallons per acre. The earlier varieties had just commenced to wither off. No disease was to be found on the haulm of any of the plots or in the immediate neighbourhood at this time, and none appeared for about three weeks, during the whole of which time the blue deposit of the mixture remained apparent on the foliage. A second dressing was applied to the later varieties, plots 1 to 12 (except 3) on August 16th, the same quantity of the mixture being used. At this time the earlier varieties, Beauty of Hebron and Webber's Early Beauty, had ripened off without showing any signs of disease in the haulm. The later-planted Beauty of Hebrons, however, were still green, whilst the undressed portions had taken the disease badly. A few spots were also to be seen on the undressed portions of the other later plots, and within a few days these commenced rapidly to decay, whilst the dressed areas remained green for a month longer until cut off by the frost. The varieties which held out longest in full growth were Imperators, Main Crop, Bruce, and Reading Giant.

On the plots other than the experimental stations, to which dressings were applied there was the same prolonged growth after the undressed areas had decayed, continuing in the case of all the later varieties until the frost of September 17th.

The crop was raised between October 3rd and 10th in dry weather, except plot 10, Imperators, which, being still green, were left. These were finally cut down by the frost about October 18th, but constant rain prevented digging before November 7th.

The produce of each plot was placed in a separate bag at the time of digging and labelled. They were afterwards weighed, and the weights checked by two members of the Committee.

Experiments at Horningsham.

At Horningsham the first dressing of the copper solution was applied on July 20th. Disease had not generally appeared in the district at this time, nor did it do so until nearly a month later, but a patch of potatoes in a garden adjoining the experimental plots was at this time considerably spotted with disease in one corner, where it was stated that refuse was generally thrown. On the experimental plot nearest this garden one or two spots of disease were noticed when the first dressing was applied. The haulm on all the plots was then over 3 feet in height, and most luxuriant in growth; so much so that some difficulty was experienced in getting between the ranks to apply the dressing.

The second dressing was applied on August 17th. At this time disease had appeared generally at Horningsham, and had attacked the whole of the undressed area of the plots. Within a week after this the haulm on these parts of the plots had almost completely decayed. The dressed area remained green, with only a few spots of disease, for a month or five weeks afterwards.

The frosts which are referred to in connection with the Warminster experiments did not affect the Horningsham plots.

EXPERIMENTS IN GREAT BRITAIN.

Experiments by Wilts County Council.

Experiments at Heytesbury.

The crop was raised in fine weather on October 10th to 12th, and weighed on the ground.

In the experiments at Heytesbury a dressing of the copper solution was applied on July 21st. No trace of disease was at this time apparent, and none appeared in the immediate locality for more than five weeks afterwards, by which time the whole of the plots had withered off. Notwithstanding that no disease appeared, the dressed portions of the plots remained green somewhat longer than the remainder, and it will be seen that they yielded a heavier crop. Some allowance, however, must be made for the effects of frost on the outside rows which formed part of the undressed area.

The crop was raised in fine weather, on September 24th and 26th. As was anticipated the quantity of diseased tubers was very small.

On certain of the areas dressed the ordinary bouillie bordelaise (2 lbs. sulphate of copper and 1 lb. lime in 10 gallons) was used side by side with the Perret solution.

The seed of some of the potatoes experimented with was soaked for 24 hours in sulphate of ammonia and nitrate of soda before planting. In some cases the seed was killed and did not germinate. In three cases where germination took place there was no comparative gain from the soaking.

Results.

The results of the experiments are shown in the tables which follow: —

A.—WARMINSTER. 12 perches, different varieties, all adjoining, 6 perches dressed twice, July 20th and August 16th, and 6 perches left undressed in such manner as to divide each plot.

Plot.	Variety.	Not Dressed.		Dressed.			Gain of Sound Tubers per acre.		Gain of Sound Tubers per cent.
		Sound.	Diseased.	Sound.	Diseased.	Equal to per acre Sound Tubers.			
		Lbs.	Lbs.	Lbs.	Lbs.	Ton. Cwt.	Ton.	Cwt.	
11.	White Elephant	65	28½	105¼	3½	15 2	5	16	62½
5.	Reading Giant	100½	6½	135¼	3	19 6	5	0	35
8.	White Elephant (Soaked Seed).	67½	23	90½	6	12 19	3	6	34
7.	Main Crop (Soaked Seed).	108½	2	141½	—	20 4	4	14	30½
1.	Schoolmaster	67	22	85	3½	12 3	2	11	27
12.	Bruce	107¾	2¼	132	¼	18 17	3	9	22½
10.	Imperator	177½	6½	208¾	1½	29 17	4	10	17½
9.	Bruce (Soaked Seed)	109	1¾	121¼	½	17 6	1	14½	11
4.	Main Crop	119½	2	130½	—	18 13	1	11½	9
3.	Webber's Early Beauty	72¾	7	78	2½	11 3		15	7
2.	Magnum Bonum	93¾	1½	99½	2	14 4½		16½ (loss)	6 (loss)
6.	Reading Russet	86	18¾	79¾	7	11 8		18	7
		1,174¾	121½	1,407¾	29¾	16 15	2	15	19·6

Experiments by Wilts County Council.

B.—WARMINSTER. 2 perches late planted, 1 perch dressed, 1 perch not dressed.

Plots.	Variety.	Not Dressed.		Dressed.			Gain at per acre.		Gain per cent.
		Sound.	Diseased.	Sound.	Diseased.	Equal to per acre Sound Tubers.			
19, 20.	Beauty of Hebron -	Lbs. 93¼	Lbs. 54	Lbs. 128½	Lbs. 11½	Ton. Cwt. 9 3½	Ton. 2	Cwt. 10	37·4

C.—HORNINGSHAM. 20 perches, Reading Giant.

Not Dressed, 10 Perches.		Dressed, 10 Perches.				Gain of Sound Tubers at per acre.		Gain of Sound Tubers, per cent.
Sound.	Diseased.	Sound.	Diseased.	Equal to per acre, Sound Tubers.				
Lbs. 2,147½	Lbs. 150	Lbs. 2,531½	Lbs. 78	Ton. 18	Cwt. 1½	Ton. 2	Cwt. 15	17·9

Results of other experiments.

D.—Plots other than the Experimental Plots to which Dressing were applied.

Owner.	Variety.	Not Dressed.			Dressed.		
		Perches.	Sound.	Diseased.	Perches.	Sound.	Diseased.
Mr. G. Trollope -	Magnum Bonum -	16	Lbs. 2,688	Lbs. 140	16	Lbs. 3,612	Lbs. 20
Mr. F. Shepherd -	Magnum Bonum -	16	2,639	19	16	2,961	4
Mr. H. J. Wakeman	Magnum Bonum -	3	570	22	3	708	½
Mr. J. W. Atkins -	Daniell - -	7½	1,290	222	7½	1,445	67
Mr. E. S. Beaven -	Bruce - -	2½	305	31	2½	356	6
„ „ -	Imperator - -	2½	430	21	2½	493	4
Mr. F. J. N. Glass -	Reading Giant -	2½	486	33	2½	566	3
Mr. J. Smith -	Reading Russet -	1	110	44	1	135	17
		51	8,518	532	51	10,276	121½
						8,518	

Gain from Dressing 51 perches - - 1,758 lbs.

Equal to 2 tons, 9 cwts. per acre, or 20·6 per cent.

SUMMARY.

	Not Dressed.					Dressed.					Gain per acre.		Gain per cent.
	No. of Perches.	Sound.	Diseased.	Equal to per acre Sound Tubers.		No. of Perches.	Sound.	Diseased.	Equal to per acre Sound Tubers.				
		Lbs.	Lbs.	Ton.	Cwt.		Lbs.	Lbs.	Ton.	Cwt.	Ton.	Cwt.	
A	6	1,174¾	121¼	14	0	6	1,407¾	29¾	16	15	2	15	19·6
B	1	93¼	54	6	13½	1	128½	11¼	9	3½	2	10	37·4
C	10	2,147½	150	15	6½	10	2,531¼	78	18	1½	2	15	17·9
D	51	8,518	532	11	18½	51	10,276	121½	14	8	2	9½	20·6
Total	68	11,933¾	857¼	12	10½	68	14,343¾	240¾	15	1½	2	11	20·1

NOTE.—On all the above areas disease appeared in the haulm either on the undressed only, or on both the undressed and the dressed portions.

WARMINSTER. 10 perches, Beauty of Hebron. Early planted Plots, 13 to 18, and 21 to 24.

	Not Dressed (5 Perches).				Dressed (5 Perches).			
	Sound.		Diseased.		Sound.		Diseased.	
	Lbs. 76[illegible]¾		Lbs. 79		Lbs. 753¾		Lbs. 40¾	
	Tons.	Cwts.	Tons.	Cwts.	Tons.	Cwts.	Tons.	Cwts.
Equal to per acre.	10	18	1	2½	10	15	0	11½

HEYTESBURY. 17 perches, White Elephant.

	Not Dressed (7 Perches).				Dressed (10 perches).			
	Sound.		Diseased.		Sound.		Diseased.	
	Lbs. 644		Lbs. 11		Lbs. 1,171		Lbs. 4¼	
	Tons.	Cwts.	Tons.	Cwts.	Tons.	Cwts.	Tons.	Cwts.
Equal to per acre	6	11	0	2	8	7	0	0½

NOTE.—On the Heytesbury plots the undressed portions were more affected by frost than the dressed portions.

The above results show that the average gain in sound potatoes on the entire area dressed was at the rate of 2 tons 11 cwts. per acre, leaving out of account those areas where no disease appeared in the haulm. In some cases the gain was at the rate of as much as 5 tons per acre.

Experiments by Wilts County Council.

In all cases where an increased crop of sound tubers followed from the dressing, there was a prolonged growth of the haulm, evidently due to the protection afforded by the copper solution, and the growth of the tubers in size corresponded to the increased growth of haulm. In most cases the haulm of the dressed areas was green from three to five weeks after that of the undressed areas had completely succumbed to the disease and rotted away. This prolonged growth would have lasted even longer if it had not been for a very early frost on the night of September 17th, when 8 degrees below freezing point was registered at Warminster.

On the dressed half of plot 10 at Warminster the Imperators were green and growing on October 13th, more than five weeks after the haulm of all the undressed potatoes in the neighbourhood had decayed.

Further experiments necessary to determine quantity and strength of solution.

It is remarked that further experiments are necessary to determine the quantity and strength of the solution required to give the best results. In these experiments, the quantity used was from 150 to 200 gallons per acre (about 1 to 1¼ gallons per perch) at each application. In all cases, 2 lbs. of copper sulphate were used to each 10 gallons of mixture.

Experiments by the Kent County Council.

Experiments by the Kent County Council.

In 1892 some experiments with Boullie Bordelaise to prevent potato disease were carried out by an Experiments Committee appointed by the Horticultural College, Swanley, under the sanction of the Kent County Council.

The experiments were made at the Horticultural College, Swanley, on four equal-sized plots of potatoes planted as shown on the subjoined plan, each containing one-fifth of an acre, and planted with five varieties, viz., The General, Beauty of Hebron, Magnum Bonum, Snowflake, and Dunbar Regents.

The liquid for spraying was a 2 per cent. solution, consisting of 4 lbs. sulphate of copper, 4 lbs. quicklime, to 20 gallons of water.

Plot 1 was dressed three times (on 27th June, 14th July, and 1st August). The first two applications were made to the whole surface of the foliage, and the third to the under side of the leaves.

Plot 2 was dressed once only (on 18th July), 4 lbs. of molasses being added to the above solution to cause the copper to adhere better to the leaves.

EXPERIMENTS IN GREAT BRITAIN.

Experiments by the Kent County Council.

Plot 3 was not treated, and served as a control plot for the experiments.

Plot 4 was dressed once, on July 18th.

	1.	2.	3.	4.
65 feet.	45 ft. VARIETY.— MANURE.— PLANTING.	45 ft. The General. Farm yard. —Dibbled.	45 ft.	45 ft.
36	VARIETY.— 3 rows + Nitr 3 rows + Kai MANURE. —	Beauty of Hebr ate of soda; rat nit; rate, 3 cwt. Farm yard.	on. e. 2 cwt. per acr per acre. PLANTING.—	e. Dibbled.
12	Magnum Bon	um.—Farm yar	d.—Baulked.	
34	VARIETY.— MANURE. — PLANTING.	Snowflake. Farm yard. —Baulked.		
35	VARIETY.— MANURE. — PLANTING.	Snowflake. Farm yard. —Dibbled.		
26	VARIETY.— MANURE. — PLANTING.	Dunbar Regent 6 cwt. Manches —Dibbled.	s. ter manure.	
	3 sprayings.	1 spraying. + molasses.	Not sprayed.	1 spraying.

The results are recorded in the following table :—

Results.

RESULTS of the EXPERIMENTS to prevent POTATO DISEASE made at the Horticultural College, Swanley, 1892.

Variety of Potato.	Area Sown.	Size of Potato.	Plot 1.	Plot 2.	Plot 3.	Plot 4.
	Sq. yds.	*Healthy* :—	Lbs.	Lbs.	Lbs.	Lbs.
The General - -	325	Large -	392	392	352	302
		Medium	224	224	181½	182
		Small -	73	48½	49	56
		Diseased -	2½	1	8	½
		Healthy :—				
Beauty of Hebron -	110	Large -	168	224	168	233
		Medium	56	44½	59½	84
		Small -	14	13	12	22
		Diseased -	5	18	60	9

Experiments by the Kent County Council.

Variety of Potato.	Area Sown.	Size of Potato.	Plot 1.	Plot 2.	Plot 3.	Plot 4.
Beauty of Hebron -	35	*Healthy:*—	Lbs.	Lbs.	Lbs.	Lbs.
		Large -	56	48	36	65
		Medium	15	5½	12½	27
		Small -	3	2	2½	11
		Diseased -	1½	3½	16½	3½
Beauty of Hebron -	35	*Healthy:*—				
		Large -	56	82½	50½	59½
		Medium	15	19½	20	24
		Small -	5	5½	3	6
		Diseased -	½	8½	14¼	5
Magnum Bonum -	60	*Healthy:*—				
		Large -	132	94½	82½	112
		Medium	19	22	22½	11
		Small -	4½	6½	6	12
		Diseased -	1	3½	5½	1½
Snowflake - -	170	*Healthy:*—				
		Large -	168	168	163	224
		Medium	63	74	89½	82
		Small -	15½	26½	20	26
		Diseased -	4	18	31	24½
Snowflake - -	173	*Healthy:*—				
		Large -	20	24	21	33
		Medium	32	35	35	32
		Small -	26	27	44	30
		Diseased -	½	2½	5	1½
Dunbar Regents -	130	*Healthy:*—				
		Large -	179	132½	126	174
		Medium	77	76	63½	59
		Small -	22	30½	20	22
		Diseased -	2½	35	40½	10
Total - -	1,040	- - -	1,835	1,824½	1,649½	1,888
Analysis - - - -		*Healthy:*—	Lbs.	Lbs.	Lbs.	Lbs.
		Large -	1,171	1,165½	1,008	1,202½
		Medium	501	500½	484	501
		Small -	163	158½	157½	185
		Diseased -	17¼	90	180¾	55¼

Note.—All the varieties were dibbled, with the exception of Magnum Bonum and Snowflake, which were baulked.

Cost per acre.

The Committee state in their Report of 20th October 1892 that a man using Vermorel's knapsack sprayer, known as the "Eclair," can spray about an acre in a day, the cost per acre being approximately—

	s.	*d.*
25 lbs. sulphate of copper, at 18*s.* 8*d.* per cwt -	4	2
25 lbs. quicklime - - - -	0	6
Labour - - - - - -	3	0
125 gallons water - - - -	0	0
	7	8

Experiments by the Kent County Council.

The trial plots of potatoes were dug on the 26th, 27th, and 28th September. The potatoes of adjoining plots, dug at the same time, were one fifth diseased.

The diseased tubers in experimental plots were found on comparatively few plants.

The Committee considered that no useful result was obtained by the addition of molasses to the mixture, but they found that the 2 per cent. solution of sulphate of copper and lime is efficacious in preventing potato disease, and they strongly recommend its general use.

EXPERIMENTS BY MESSRS. CARTER & CO. AT BROMLEY.

Experiments by Messrs. Carter & Co.

In 1892 Messrs. Carter & Co. carried out a series of experiments with bouillie bordelaise at Bromley.

The land upon which the experiments were conducted is a poor clay sand on the London clay, and was in a most unsatisfactory condition when the potatoes were put in. Oats preceded the potatoes. Eight loads of farmyard manure were put on the acre of trial ground. It was twice ploughed, and the potatoes were planted on April 8th, 1892. The land was harrowed and horse-hoed twice.

The potatoes were put in 10 long double rows, the drills being 36 inches apart, a distance which some potato growers hold to be better and more profitable than closer planting.

Varieties of potatoes.

The following varieties were planted:—

Row No. 1.—Myatt's Ashleaf.
„ 2.—Snowdrop.
„ 3.—Beauty of Hebron.
„ 4.—White Elephant.
„ 5.—Carter's King of the Russets.
„ 6.—Carter's Cosmopolitan.
„ 7.—Carter's Improved Magnum Bonum.
„ 8.—Bruce.
„ 9.—Carter's Surprise.
„ 10.—Imperator.

The whole piece was divided into four equal parts. The first and third of these parts was dressed with bouillie bordelaise; the second and fourth were not dressed at all.

Dates of application of dressings.

The first dressing was given on July 11th; the second on August 2nd.

The bouillie was made with 22 lbs. of sulphate of copper and 22 lbs. of lime to 100 gallons of water.

Disease appeared early in September in the undressed parts of the trial ground.

The potatoes were dug on the 15th and 16th of September, when the following results were noted and tabulated, as below:—

1. FIRST QUARTER PLOT.—DRESSED.

Row and Variety.	Weight of Sound Tubers.			Weight of Diseased Tubers.			Total.		
	Cwt.	qrs.	lbs.	Cwt.	qrs.	lbs.	Cwt.	qrs.	lbs.
1. Myatt's	3	1	5	0	0	1½	3	1	6½
2. Snowdrops	2	2	12	0	0	1¾	2	2	13¾
3. Beauty of Hebron	2	3	18	0	0	2½	2	3	20½
4. White Elephant	3	2	19	0	0	2	3	2	21
5. King of the Russets	3	3	14		None		3	3	14
6. Cosmopolitan	2	2	7	0	0	0½	2	2	7½
7. Magnum Bonum	3	2	19		None		3	2	19
8. The Bruce	4	0	0		None		4	0	0
9. Carter's Surprise	3	2	10		None		3	2	10
10. Imperator	4	3	10		None		4	3	10
Totals	35	0	2	0	0	8¼	35	0	10¼

2. SECOND QUARTER PLOT.—UNDRESSED.

Row and Variety.	Weight of Sound Tubers.			Weight of Diseased Tubers.			Total.		
	Cwt.	qrs.	lbs.	Cwt.	qrs.	lbs.	Cwt.	qrs.	lbs.
1. Myatt's	1	2	17	0	3	25	2	2	14
2. Snowdrops	1	3	10	0	1	21	2	1	3
3. Beauty of Hebron	2	0	10	0	1	12	2	1	22
4. White Elephant	2	0	25	0	3	21	3	0	18
5. King of the Russets	3	2	5	0	0	12	3	2	17
6. Cosmopolitan	2	0	0	0	1	7	2	1	7
7. Magnum Bonum	3	0	21	0	0	5	3	0	26
8. The Bruce	3	2	0	0	0	7	3	2	7
9. Carter's Surprise	2	1	10	0	0	25	2	2	7
10. Imperator	3	2	23	0	0	16	3	3	11
Totals	26	0	9	3	2	11	29	2	20

3. THIRD QUARTER PLOT.—DRESSED.

Row and Variety.	Weight of Sound Tubers.			Weight of Diseased Tubers.			Total.		
	Cwt.	qrs.	lbs.	Cwt.	qrs.	lbs.	Cwt.	qrs.	lbs.
1. Myatt's	1	1	13	0	0	0¼	1	1	13¼
2. Snowdrops	1	1	21	0	0	0½	1	1	21½
3. Beauty of Hebron	1	3	12	0	0	1¾	1	3	13¾
4. White Elephant	2	3	17		None		2	3	17
5. King of the Russets	2	2	9		None		2	2	9
6. Cosmopolitan	1	2	7		None		1	2	7
7. Magnum Bonum	2	3	0		None		2	3	0
8. The Bruce	3	0	23		None		3	0	23
9. Carter's Surprise	2	2	0		None		2	2	0
10. Imperator	2	3	8	0	0	0¼	2	3	8¼
Totals	22	3	26	0	0	2¾	23	0	0¾

EXPERIMENTS IN GREAT BRITAIN.

Experiments by Messrs. Carter & Co.

4. FOURTH QUARTER PLOT.—UNDRESSED.

Row and Variety.	Weight of Sound Tubers.			Weight of Diseased Tubers.			Total.		
	Cwt.	qrs.	lbs.	Cwt.	qrs.	lbs.	Cwt.	qrs.	lbs.
1. Myatt's	0	3	14	0	1	14	1	1	0
2. Snowdrops	0	2	26	0	2	14	1	1	12
3. Beauty of Hebron	0	3	16	0	2	23	1	2	11
4. White Elephant	1	0	14	0	3	7	1	3	21
5. King of the Russets	1	2	0	0	1	0	1	3	0
6. Cosmopolitan	0	3	5	0	1	0	1	0	5
7. Magnum Bonum	1	0	20	0	0	1	1	0	21
8. The Bruce	3	1	11	0	0	2	3	1	13
9. Carter's Surprise	1	1	0	0	0	14	1	1	14
10. Imperator	2	1	7	0	0	20	2	1	27
Totals	14	0	1	3	1	11	17	1	12

Results of duplicate experiments.

The following table gives the totals of the two duplicate experiments:—

	Dressed Plots.			Undressed Plots.			In favour of Dressed Plots.		
	Cwt.	qrs.	lbs.	Cwt.	qrs.	lbs.	Cwt.	qrs.	lbs.
Weight of sound tubers	58	0	0	39	2	10	18	1	18
Weight of unsound tubers	0	0	11	6	3	22	6	3	11
Total yield	58	0	11	46	2	4	11	2	7

The table appended here shows the rainfall and general weather conditions during the growth of the potatoes.

April 8th to 30th.—Rainfall, 1·50 inches (on ten days). The rain fell on continuous days from 24–25th to 28–29th (0·55 inches).

Frost was registered on 13 occasions from April 10th to 30th, in intensity ranging from 1 to 7 degrees.

Severe snowstorm 1 a.m. to 8 a.m. April 16th.

May.—Rainfall, 1·46 inches (on ten days). Very little rain (0·21 inches on eight days) until after the 24–25th; and on the 25–26th there was registered 0·97 inches.

Frost registered May 1st (5 degrees), May 7th (4 degrees).

June.—Rainfall, 2·64 inches (on 14 days). Thunderstorm 28th 8.30 p.m. to 11 p.m. Thermometer, lowest 35, highest 98.

July.—Rainfall, 2·53 inches (on eight days.) Very severe thunderstorm on the 14th, 10.15 a.m. and 12.30 midday, when 0·90 inches of rain fell. Thermometer, lowest 39, highest 90.

August.—Rainfall, 3.35 inches (on 16 days), the heaviest fall was 27–28th, 0·98 inches. Thermometer, lowest 38, highest 98.

September 1st to 14th.—Rainfall, 0·57 inches (on seven days.) Thermometer, lowest 35, highest, 83.

Experiments by Messrs. Carter & Co.

It should be noticed especially that in these experiments the treatment was intended to be solely a *preventive*, and by no means a *curative* measure, the dressing being applied before disease had appeared. No dressing was given when it was discovered that disease had made its appearance.

As Messrs. Carter put it, they wanted to prove whether it would pay potato-growers to insure, as it were, their potatoes against disease by dressing them twice, as a part of the regular routine of potato cultivation, at a cost of about 1*l.* per acre. They hold, and it is considered with much reason that they have shown by the results of these experiments, that such preventive dressing will pay well, seeing that the yield of the dressed portions of the trial ground was at the rate of two tons per acre more than that of the undressed parts. The quality of the potatoes also, was undoubtedly better on the dressed plots.

Preventive dressing pays well.

A noteworthy feature of these experiments is that double the quantity of lime was used for them compared with that used in the experiments conducted by the Royal Agricultural Society for the Board of Agriculture.

EXPERIMENTS IN IRELAND.

Experiments by Irish Land Commission.

REPORT ON EXPERIMENTS CARRIED OUT BY THE AGRICULTURAL DEPARTMENT OF THE IRISH LAND COMMISSION IN 1892.

The Agricultural Department of the Irish Land Commission carried out a series of experiments during the late summer and autumn of 1892 for the purpose of testing the value of applications of sulphate of copper to the potato plant as a preventive of potato disease.

The farms upon which the experiments were conducted were situated as follows :—

Two near Tralee, county Kerry.
Two near Clonakilty, county Cork.
Two near Tramore, county Waterford.
Three near Brookeboro', county Fermanagh.

All these experiments were carried out under the superintendence of Mr. A. William West, M.R.A.C.

Further experiments were conducted by Mr. W. A. Barnes, of Westlands, Moynalty, Kells, county Meath, and by the Dungannon Board of Guardians, both being carried out in accordance with instructions given by this Department.

"Champion" variety experimented on.

In all cases the Champion variety of potato was selected for experiment, being the variety most generally grown for home consumption in Ireland. At each experimental station five quarter acre plots were carefully measured out; plots 1 to 4 were treated with the mixtures described in the following table, plot 5 was left untreated as a check plot :—

Materials Used.	Plot 1.	Plot 2.	Plot 3.	Plot 4.
	Per Acre.	Per Acre.	Per Acre.	Per Acre.
Pure sulphate of copper -	30 lbs.	30 lbs.	22½ lbs.	22½ lbs.
Unslacked lime - -	15 lbs.	15 lbs.	7½ lbs.	7½ lbs.
Water - - -	150 galls.	150 galls.	150 galls.	150 galls.
Treacle - - -	—	30 lbs.	—	22½ lbs.
	2 per cent. of copper sulphate.		1½ per cent. of copper sulphate.	

In all the experiments except No. 9 (Brookeboro') the plots were dressed three times at intervals of about three weeks; in experiment No. 9 the dressing was only applied once.

Care was taken in marking off the plots that they should be as nearly as possible similar with respect to soil, seed used, and

Experiments by Irish Land Commission.

general treatment before and during the growth of the crops, but the soil varied considerably in the plots used for experiment No. 6, at Tramore, and for experiment No. 2 at Ardfert Abbey, the plots in the first instance being subject to springs, and those in the second case being partly situated on the slope of a rather steep hill.

The sulphate of copper used was that known as pure sulphate of copper. A sample, drawn from the sulphate of copper sent out for the purposes of the experiments, was submitted to Sir Charles A. Cameron, Analyst to the City and County of Dublin, and was certified by him to be of 98·5 per cent. of purity

Sir Charles Cameron reported as follows:—

"City Laboratory,
"Municipal Buildings, Cork Hill,
"Dublin, July 20th, 1892.

"I have analysed a specimen of sulphate of copper submitted to me for that purpose by the Irish Land Commission, the only impurity present is sulphate of iron. The amount of iron present is 0·49 per cent. which would give an equivalent of 0·7 per cent. of peroxide of iron. The exact amount of pure sulphate of copper present is 98·5 per cent.

"(Signed), CHARLES A. CAMERON."

The lime used was thoroughly well-burned, unslaked lime.

Preparation of dressings.

The spraying mixtures were prepared as follows:—

The requisite amount of copper sulphate was set to dissolve over night by placing it in a piece of coarse sacking, suspended in a wooden barrel containing two gallons of cold water to every pound of copper sulphate, or if this could not conveniently be done, the copper sulphate was ground to powder previous to being placed in water; when thus powdered it dissolves in a few minutes in cold water; the correct amount of unslacked lime was then placed in a bucket, and water was added until the lime would absorb no more; upon the whole of the lime being thoroughly slacked, sufficient water was added thereto to thoroughly cool the lime, producing a thin milk of lime, which was well stirred and then poured slowly into the copper sulphate solution, this mixture was then stirred for several minutes, after which sufficient cold water was added to dilute it to the required strength, the whole being continuously stirred. After thorough stirring, the mixture appeared azure-blue in colour, it was then allowed to rest in order that the precipitate should sink; if after standing for a few minutes the precipitate sank leaving a few inches in depth of clear liquid it was considered ready for use, but if the liquid to the depth mentioned instead of appearing clear was slightly tinged with blue, the mixture was again thoroughly stirred and allowed to rest a second time. This second stirring generally produced the desired effect, but if, as occurred in one or two instances, it did not, more lime was added, the bluish tinge showing that the whole of the copper had not been thoroughly precipitated; the addition of a few ounces of lime was found sufficient in each instance to bring about the

EXPERIMENTS IN IRELAND.

desired result. On being tested with litmus paper the mixture as thus prepared proved to be free from acidity.

Experiments by Irish Land Commission.

It will be observed by reference to the table above that the proportion of lime to copper sulphate used was as 1 to 2 on plots 1 and 2, and as 1 to 3 on plots 3 and 4; it was found that if the lime was thoroughly good, the latter proportion was sufficient to neutralize all the acid and to precipitate all the copper. Unless the acidity of the copper sulphate is neutralized the mixture would be injurious to the leaves of the potato plant, therefore, if the lime used is not of very good quality, it is advisable to use it in the proportion of one part of lime to two parts of copper sulphate.

Acidity of copper sulphate must be neutralised.

Treacle mixture.

When preparing the treacle mixture, sufficient water was added to the required amount of treacle to make it of a thin consistency, the diluted treacle was then added to the milk of lime, and after being thoroughly stirred, the mixture was poured into the copper solution in the barrel, the whole being again thoroughly stirred.

The object of adding treacle to the mixture applied to two of the plots in each experiment, was to ascertain whether the addition of treacle to the sulphate of copper mixture as recommended by M. Perret and M. Girard, would produce more satisfactory results than the applications of the ordinary bouillie bordelaise, M. Girard's experiments tending to show that the sucrated mixture was less liable to be washed off the potato leaves by rain.

Eclair sprayer used.

The mixture was applied by means of the "Éclair" knapsack spraying machine made by Vermorel, a full description of which appeared in the report of the experiments of a similar nature conducted by this Department in 1891. The machines, which cost 35*s.* each, proved most satisfactory in every respect.

The mixtures were prepared in the fields in which the experiments were carried out, forty gallon wooden paraffin barrels being used for the purpose.

In most of the experiments three machines were kept constantly at work; at other times two, four, or five machines were used. From the experience thus gained it was ascertained that one strong boy could attend three men operating the spraying, the boy being employed to carry fresh supplies of the mixture to the operators from barrels placed on the headlands, the mixture being well stirred before drawing a fresh supply.

Dressings applied from above and from underneath.

The mixture was applied to the plants both from above and from underneath, in every instance, excepts in experiment No. 5, the foliage of the crop in that instance being so rank, that it was found impossible to spray from underneath to any appreciable extent.

In each experiment the actual time occupied in preparing and appplying the mixture was noted down, and the following estimates of the cost of application to an average crop of

Champions, with fully developed stalks, is based upon the information thus obtained :—

Three men using "Éclair" sprayers, attended by one boy, can apply 150 gallons to one statute acre in $5\frac{1}{4}$ hours. Experiments by Irish Land Commission.

If less than three men are employed the cost of attendance per acre is proportionately greater.

The price of the copper sulphate, delivered on the farm, may be estimated at 21*s.* per cwt. equal to $2\frac{1}{4}$*d.* per lb., and the price of treacle at 1*d.* per lb.

The cost of labour may be estimated at 2*s.* per diem for each man, and 1*s.* per diem for the attendant boy. The working day is calculated at $10\frac{1}{2}$ hours.

The cost of each application per acre would be as follows :—

Total cost of applying the 2 per cent. mixture with and without treacle :— Cost of treatment.

———	Plot I.	Plot II.
	£ *s.* *d.*	£ *s.* *d.*
3 men working Éclair sprayers	0 3 0	0 3 0
1 boy in attendance	0 0 6	0 0 6
30 lbs. copper sulphate at $2\frac{1}{4}$*d.* lb.	0 5 $7\frac{1}{2}$	0 5 $7\frac{1}{2}$
15 lbs. lime	—	—
30 lbs. treacle at 1*d.* lb.	—	0 2 6
Total per acre	0 9 $1\frac{1}{2}$	0 11 $7\frac{1}{2}$

Total cost of applying the $1\frac{1}{2}$ per cent. mixture with and without treacle :—

———	Plot III.	Plot IV.
	£ *s.* *d.*	£ *s.* *d.*
3 men working "Éclair" sprayers	0 3 0	0 3 0
1 boy in attendance	0 0 6	0 0 6
$22\frac{1}{2}$ lbs. copper sulphate at $2\frac{1}{4}$*d.* lb.	0 4 $2\frac{1}{2}$	0 4 $2\frac{1}{2}$
$7\frac{1}{2}$ lbs. lime	—	—
$22\frac{1}{2}$ lbs. treacle at 1*d.* lb.	—	0 1 $10\frac{1}{2}$
Total per acre	0 7 $8\frac{1}{2}$	0 9 7

During the first three weeks of October a statute perch in each plot was carefully measured off and the potatoes therein dug; generally speaking, half a perch was taken in two different parts of each plot; the sound potatoes were separated from the unsound; the former were then further divided into two lots, one being marketable potatoes, fit for human consumption, the other lot being small potatoes, fit for feeding pigs, poultry, &c. The three lots were then separately weighed; in many instances a considerable amount of the tubers in the untreated plots were found to have rotted away.

The statistical results of the several experiments are shown on the following pages.

EXPERIMENTS IN IRELAND.

Experiments by Irish Laud Commission.

Experiment No. I.

EXPERIMENT No. 1.—COUNTY KERRY.

Name.—DAVID WATSON. Address.—Ballysheen, Abbeydorney.

Source of Seed.—Imported from Forfar in 1891.

Date of first dressing.—Plot 1 on 30th June. Plots 2, 3, and 4 on 1st July.

Appearance of crop.—Perfectly healthy, but not a heavy show of foliage.

Weather at time of application.—30th June, a little windy. Heavy shower when half through plot 1. 1st July, bright sunny day.

General remarks.—On plot 1 the solution was unintentionally applied at the rate of 300 gallons per acre.

Date of second dressing.—22nd July.

Appearance of crop.—Still quite free from disease; the foliage did not appear to be as heavy on the treated as on the untreated plots.

Weather at time of application.—Fine.

Date of third dressing.—13th August.

Appearance of crop.—On plot 5 every plant was badly attacked by disease. On the four treated plots disease was only observable on two or three spots, and the plants appeared to have greater vitality than those untreated.

Weather at time of application.—Fine, but very windy.

General remarks.—Notwithstanding excessive rain during the whole of the day and night preceding the day on which the third dressing was applied, indications of the previous dressing were still to be observed in the form of a deposit upon the leaves and stalks.

YIELD of POTATOES and ESTIMATED VALUE of the PRODUCE, deducting the cost of Preventive Treatment calculated per Statute Acre, from the Results obtained upon the Experimental Plots.

Treatment, per Acre.	—	Total Sound.	Diseased.	Total Crop.	Cost of Application.
(1.)					
30 lbs. copper sulphate	Weight per acre	T. c. lb. 8 6 48	T. c. lb. 0 6 88	T. c. lb. 8 13 24	
15 lbs. lime	Per cent. to entire crop.	96·1	3·9	100·0	
150 gallons water	Market value	£ s. d. 15 6 5	£ s. d. —	£ s. d. 15 6 5	£ s. d. 1 7 4½
(2.)					
30 lbs. copper sulphate	Weight per acre	T. c. lb. 7 12 96	T. c. lb. 0 6 8	T. c. lb. 7 18 104	
15 lbs. lime	Per cent. to entire crop.	96·18	3·82	100·0	
30 lbs. treacle					
150 gallons water	Market value	£ s. d. 14 4 10	£ s. d. —	£ s. d. 14 4 10	£ s. d. 1 14 10½
(3.)					
22½ lbs. copper sulphate	Weight per acre	T. c. lb. 9 5 40	T. c. lb. 0 8 4	T. c. lb. 9 13 44	
7½ lbs. lime	Per cent. to entire crop.	95·0	4·1	100·0	
150 gallons water	Market value	£ s. d. 17 16 9	£ s. d. —	£ s. d. 17 16 9	£ s. d. 1 3 1½
(4.)					
22½ lbs. copper sulphate	Weight per acre	T. c. lb. 8 0 80	T. c. lb. 0 6 88	T. c. lb. 8 7 56	
7½ lbs. lime	Per cent. to entire crop.	96·0	4·0	100·0	
22½ lbs. treacle					
150 gallons water	Market value	£ s. d. 15 8 7	£ s. d. —	£ s. d. 15 8 7	£ s. d. 1 8 9
(5.)					
Untreated	Weight per acre	T. c. lb. 6 14 32	T. c. lb. 1 5 0	T. c. lb. 7 19 32	
	Per cent. to entire crop.	84·3	15·7	100·0	
	Market value	£ s. d. 12 10 8	£ s. d. —	£ s. d. 12 10 8	

Gain on three plots; loss of only 8½*d.*

On plots 1, 3, and 4 there was a net gain per acre of 1*l.* 8*s.* 4½*d.*, 4*l.* 2*s.* 11½*d.*, and 1*l.* 9*s.* 2*d.* respectively; while on plot 2 there was a loss of 8½*d.* per acre.

EXPERIMENT No. II.—COUNTY KERRY.

Name.—W. T. TALBOT-CROSBIE, Esquire.

Address.—Ardfert Abbey, Ardfert

Date of first dressing.—2nd July.

Appearance of crop.—A fine healthy looking crop.

Weather at time of application.—Raining off and on the whole time, sometimes heavily.

General remarks.—A great deal of time and inconvenience was saved in preparing the solution by using a water cart, which contained all the water required for dressing 1 acre.

Date of second dressing.—29th July.

Appearance of crop.—The blight was just appearing on the crop; more apparent on the untreated than on the treated plot; otherwise the crop was quite healthy and in flourishing condition.

Weather at time of application.—A very fine day with no wind.

Date of third dressing.—20th August.

Appearance of crop.—Treated plots quite green and many of the plants in flower. Plots 1 and 2 very slightly affected by disease, especially No. 1, on which only a few spots were to be seen. Plots 3 and 4 were not so free from disease as plot 1, but were still quite green in appearance. The untreated plot was a most marked contrast, being quite black with the disease and hardly a green leaf to be seen.

General remarks.—Very heavy rain during portions of the two days following.

YIELD of POTATOES and ESTIMATED VALUE of the PRODUCE, deducting the cost of Preventive Treatment, calculated per Statute Acre, from the Results obtained upon the Experimental Plots.

Treatment per Acre.	—	Total Sound.	Diseased.	Total Crop.	Cost of Application.
(1.)					
30 lbs. copper sulphate	Weight per acre	T. c. lb. 9 2 96	T. c. lb. 0 17 96	T. c. lb. 10 0 80	
15 lbs. lime	Per cent. to entire crop.	91·1	8·9	100·0	
150 gallons water	Market value	£ s. d. 17 5 9	£ s. d. —	£ s. d. 17 5 9	£ s. d. 1 7 4½
(2.)					
30 lbs. copper sulphate	Weight per acre	T. c. lb. 7 15 0	T. c. lb. 0 12 16	T. c. lb. 8 7 16	
15 lbs. lime	Per cent. to entire crop.	92·7	7·3	100·0	
30 lbs. treacle					
150 gallons water	Market value	£ s. d. 14 11 5	£ s. d. —	£ s. d. 14 11 5	£ s. d. 1 14 10½
(3.)					
22½ lbs. copper sulphate	Weight per acre	T. c. lb. 7 4 32	T. c. lb. 0 17 96	T. c. lb. 8 2 16	
7½ lbs. lime	Per cent. to entire crop.	89·0	11·0	100·0	
150 gallons water	Market value	£ s. d. 13 16 5	£ s. d. —	£ s. d. 13 16 5	£ s. d. 1 3 1½
(4.)					
22½ lbs. copper sulphate	Weight per acre	T. c. lb. 7 14 32	T. c. lb. 0 12 16	T. c. lb. 8 6 48	
7½ lbs. lime	Per cent. to entire crop.	92·7	7·3	100·0	
22½ lbs. treacle					
150 gallons water	Market value	£ s. d. 14 7 10	£ s. d. —	£ s. d. 14 7 10	£ s. d. 1 8 9
(5.)					
Untreated	Weight per acre	T. c. lb. 7 12 96	T. c. lb. 0 19 32	T. c. lb. 8 12 16	
	Per cent. to entire crop.	88·8	11·2	100·0	
	Market value	£ s. d. 14 9 11	£ s. d. —	£ s. d. 14 9 11	

Compared with the untreated plot, plot 1 showed a net gain per acre of 1*l.* 8*s.* 5½*d.*; while on plots 2, 3, and 4 there was a loss per acre of 1*l.* 13*s.* 4½*d.*, 1*l.* 16*s.* 7½*d.*, and 1*l.* 10*s.* 10*d.* respectively. Loss on three plots.

On these plots the dressing had, outwardly, as marked an effect on the crop as in any of the other experiments. The results obtained are possibly to a large extent due to variations in the quality of the soil in each plot. Plot 1 was at the base of a slope, plots 2, 3, and 4 were more or less on the slope, whilst plot 5 was on a flat table land above the other plots.

EXPERIMENTS IN IRELAND.

Experiments by Irish Land Commission.

Experiment No. III.

EXPERIMENT No. III.—COUNTY CORK.

Name.—D. O'LEARY, C.T.C. Address.—Darara, Clonakilty.

Date of first dressing.—6th July.

Appearance of crop.—A fair healthy crop. Early potatoes, next to the five plots of champions marked out for experiment, were very badly attacked with the blight. Only one spot was noticed on the champions.

Weather at time of application.—A heavy shower when about half through the dressing, after which fine.

General remarks.—This crop being in lazy beds, each man was made to spray one side of a bed going up the field and the other side returning.

Date of second dressing.—27th July.

Appearance of crop.—The untreated plot badly attacked with the blight. The foliage being, in places, quite discoloured. The four treated plots, although spotted, were quite green and flourishing. The difference between the foliage of treated and untreated was most marked.

Weather at time of application.—Very fine.

Date of third dressing.—18th August.

Appearance of crop.—Untreated plot a mass of diseased stalks, and no green leaves to be seen. Treated plots quite green and remarkably free from disease, being only very slightly spotted, and to all appearance still growing.

YIELD of POTATOES and ESTIMATED VALUE of the PRODUCE, deducting the cost of Preventive Treatment, calculated per Statute Acre, from the Results obtained upon the Experimental Plots.

Treatment per Acre.	—	Total Sound.	Diseased.	Total Crop.	Cost of Application.
(1.) 30 lbs. copper sulphate	Weight per acre	T. c. lb. 9 2 16	T. c. lb. 0 4 32	T. c. lb. 9 6 48	
15 lbs. lime	Per cent. to entire crop.	97·7	2·3	100·0	
150 gallons water	Market value	£ s. d. 16 17 2	£ s. d. —	£ s. d. 16 17 2	£ s. d. 1 7 4½
(2.) 30 lbs. copper sulphate	Weight per acre	T. c. lb. 8 9 32	T. c. lb. None.	T. c. lb. 8 9 32	
15 lbs. lime	Per cent. to entire crop.	100·0	0·0	100·0	
30 lbs. treacle					
150 gallons water	Market value	£ s. d. 16 0 8	£ s. d. —	£ s. d. 16 0 8	£ s. d. 1 14 10½
(3.) 22½ lbs. copper sulphate	Weight per acre	T. c. lb. 7 15 80	T. c. lb. 0 6 48	T. c. lb. 8 2 16	
7½ lbs. lime	Per cent. to entire crop.	96·03	3·97	100·0	
150 gallons water	Market value	£ s. d. 14 13 7	£ s. d. —	£ s. d. 14 13 7	£ s. d. 1 3 1½
(4.) 22½ lbs. copper sulphate	Weight per acre	T. c. lb. 8 7 96	T. c. lb. 0 2 16	T. c. lb. 8 10 0	
7½ lbs. lime	Per cent. to entire crop.	98.8	1·2	100·0	
22½ lbs. treacle					
150 gallons water	Market value	£ s. d. 15 19 3	£ s. d. —	£ s. d. 5 19 3	£ s. d. 1 8 9
(5.) Untreated	Weight per acre	T. c. lb. 3 7 96	T. c. lb. 0 10 80	T. c. lb. 3 18 64	
	Per cent. to entire crop.	86·4	13·6	100·0	
	Market value	£ s. d. 6 9 11	£ s. d. —	£ s. d. 6 9 11	

Gain on all dressed plots.

All the dressed plots showed a gain from the treatment, the net gain per acre on each plot being as follows:—Plot 1, 8*l.* 19*s.* 10½*d.*; plot 2, 7*l.* 15*s.* 10½*d.*; plot 3, 7*l.* 0*s.* 6½*d.*; plot 4, 8*l.* 0*s.* 7*d.*

EXPERIMENT No. IV.—COUNTY CORK.

Name.—M. DONOVAN. Address.—Gullane, Clonakilty.

Date of first dressing. 5th July.

Appearance of crop.—A fine healthy crop with heavy foliage. Some early potatoes in close proximity were blighted.

Weather at time of application.—At first a light drizzly rain, then quite fine.

General remarks.—This crop was in lazy beds, the haulms were so big that it was most difficult to carry the solution to the men.

Date of second dressing.—26th July.

Appearance of crop.—Both treated and untreated were spotted by the disease, but it was not so apparent on the untreated plots. There was no difference discernible among the four treated plots.

Weather at time of application.—Very fine.

Date of third dressing.—17th August, plots 1, 3, and 4; 18th August, plot 2.

Appearance of crop.—The treated plots, although spotted by disease, were quite fresh and green, a few leaves here and there turning yellow from natural decay. On the untreated plot the leaves had been quite destroyed by the blight, leaving the stalks only. There was no difference to be seen between the four treated plots, with the exception that the outside ridge of plot 1 was spotted with the blight more than the rest. This was considered due to its having been next a few ridges of early potatoes which were not dressed.

YIELD of POTATOES and ESTIMATED VALUE of the PRODUCE, deducting the cost of Preventive Treatment, calculated per Statute Acre, from the Results obtained upon the Experimental Plots.

Treatment per Acre.	—	Total Sound.	Diseased.	Total Crop.	Cost of Application.
(1.) 30 lbs. copper sulphate, 15 lbs. lime, 150 gallons water	Weight per acre	T. c. lb. 8 15 0	T. c. lb. 0 8 64	T. c. lb. 9 3 64	
	Per cent. to entire crop.	95·3	4·7	100·0	
	Market value	£ s. d. 16 10 0	£ s. d. —	£ s. d. 16 10 0	£ s. d. 1 7 4½
(2.) 30 lbs. copper sulphate, 15 lbs. lime, 30 lbs. treacle, 150 gallons water	Weight per acre	T. c. lb. 10 3 64	T. c. lb. 0 3 104	T. c. lb. 10 7 56	
	Per cent. to entire crop.	98·2	1·8	100·0	
	Market value	£ s. d. 19 0 0	£ s. d. —	£ s. d. 19 0 0	£ s. d. 1 14 10½
(4.) 22½ lbs. copper sulphate, 7½ lbs. lime, 22½ lbs. treacle, 150 gallons water	Weight per acre	T. c. lb. 8 1 48	T. c. lb. 0 3 24	T. c. lb. 8 4 72	
	Per cent. to entire crop.	98·1	1·9	100·0	
	Market value	£ s. d. 15 5 9.	£. s. d. —	£ s. d. 15 5 9	£ s. d. 1 8 9
(5.) Untreated	Weight per acre	T. c. lb. 7 17 96	T. c. lb. 0 6 48	T. c. lb. 8 4 32	
	Per cent. to entire crop.	96·1	3·9	100·0	
	Market value	£ s. d. 14 7 10	£ s. d. —	£ s. d. 14 7 10	

Plot 2 was the only plot next the untreated plot, and the portions dug for purposes of weighing in both these plots were within a few feet of one another; plot 3 had been dug before Mr. West visited the farm to test results.

Gain on two plots, loss on one.

Plots 1 and 2 showed a net gain from the treatment of 14*s.* 9½*d.* and 2*l.* 17*s.* 3½*d.* per acre respectively, while on plot 4 there was a net loss per acre of 10*s.* 10*d.*

Experiments by Irish Land Commission.

Experiment No. V.

EXPERIMENT No. V.—COUNTY WATERFORD.

Name.—JOHN HALLEY. Address.—Crobally, near Tramore.

Date of first dressing.—11th July.

Appearance of crop.—A magnificent crop; quite healthy and free from disease.

Weather at time of application.—Fine whilst spraying, but windy. Thunderstorm with exceedingly heavy rain, immediately after dressing.

General remarks.—The foliage being very high, close matted, it was impossible to carry the mixture in buckets up the drills to the men, who therefore had to return to refill the sprayers; this took up considerable time. In the case of heavy foliage like this, the plan adopted was to make each man walk backwards between the drills, spraying one side only of the drills on each side of him. This method prevents the solution being rubbed off on the men's trousers, and ensures the work being more thoroughly done.

Date of second dressing.—3rd August.

Appearance of crop.—Untreated plot badly attacked with the blight. Treated plots only slightly spotted.

Weather at time of application.—Very fine.

Date of third dressing.—23rd August.

Appearance of crop.—Treated plots quite green, with an enormous growth, and very slightly spotted by the blight. On the untreated plot the stalks only were left, the leaves being quite dark and dishevelled from the effects of the disease. The line of demarcation between the treated and untreated plots was most marked.

Weather at time of application.—A dull but fine day.

General remarks.—The foliage of this crop was too dense to allow of underneath spraying to any extent, and was nearly all dressed from above. All the treated plots except one, had been dug before Mr. West visited the farm to test results.

YIELD of POTATOES and ESTIMATED VALUE of the PRODUCE, deducting the cost of Preventive Treatment, calculated per statute acre, from the Results obtained upon the Experimental Plots.

Treatment per Acre.	—	Total Sound.	Diseased.	Total Crop.	Cost of Application.
22½ lbs. copper sulphate 7½ lbs. lime 22½ lbs. treacle 150 gallons water	Weight per acre	T. c. lb. 10 0 0	T. c. lb. 0 14 32	T. c. lb. 10 14 32	
	Per cent. to entire crop.	93·3	6·7	100·0	
	Market value	£ s. d. 18 7 1	£ s. d. —	£ s. d. 18 7 1	£ s. d. 1 8 9
Untreated	Weight per acre	T. c. lb. 6 8 64	T. c. lb. 0 18 64	T. c. lb. 7 7 16	
	Per cent. to entire crop.	87·4	12·6	100·0	
	Market value	£ s. d. 11 8 7	£ s. d. —	£ s. d. 11 8 7	

gain from ent, d.

In this experiment the portions of the treated and untreated plots dug for weighing were within 9 feet of one another.
The net gain per acre from the treatment amounted to 5*l*. 9*s*. 9*d*.

EXPERIMENT No. VI.—COUNTY WATERFORD.

Name.—WALTER HALLEY. Address.—Coolnacapogue, near Tramore.

Source of Seed.—Home-grown Champions.

Date of first dressing.—12th July.

Appearance of crop.—A very light crop of potatoes, but quite healthy, and free from disease.

Weather at time of application.—Raining, off and on, the whole time.

Date of second dressing.—2nd August.

Appearance of crop.—Blight appearing on the untreated plot; very few spots to be seen on the four treated plots. The previous dressing was still to be observed upon the leaves.

Date of third dressing.—25th August.

Appearance of crop.—Treated plots quite green, and many of the plants in flower. The upper leaves of a great many plants were slightly spotted with the blight; the lower leaves were quite free from disease, and covered with the previous dressing. This showed that the upper leaves had sheltered the lower ones from the beating action of the rain. Untreated plot quite dark from disease.

Weather at time of application.—Bright and sunny.

YIELD of POTATOES and ESTIMATED VALUE of the PRODUCE, deducting the Cost of Preventive Treatment, calculated per Statute Acre, from the Results obtained upon the Experimental Plots.

Treatment per Acre.	——	Total Sound.	Diseased.	Total Crop.	Cost of Application.
(1.) 30 lbs. copper sulphate; 15 lbs. lime; 150 gallons water	Weight per acre	T. c. lb. 9 3 64	T. c. lb. 0 5 80	T. c. lb. 9 9 32	
	Per cent. to entire crop.	97·0	3·0	100·0	
	Market value	£ s. d. 17 5 0	£ s. d. —	£ s. d. 17 5 0	£ s. d. 1 7 4½
(2.) 30 lbs. copper sulphate; 15 lbs. lime; 30 lbs. treacle; 150 gallons water	Weight per acre	T. c. lb. 7 15 0	T. c. lb. 0 0 10	T. c. lb. 7 15 10	
	Per cent. to entire crop.	99·97	·03	100·0	
	Market value	£ s. d. 14 15 0	£ s. d. —	£ s. d. 14 15 0	£ s. d. 1 14 10½
(3.) 22½ lbs. copper sulphate; 7½ lbs. lime; 150 gallons water	Weight per acre	T. c. lb. 6 15 0	T. c. lb. 0 5 0	T. c. lb. 7 0 0	
	Per cent. to entire crop.	96·4	3·6	100·0	
	Market value	£ s. d. 12 16 5	£ s. d. —	£ s. d. 12 16 5	£ s. d. 1 3 1½
(4.) 22½ lbs. copper sulphate; 7½ lbs. lime; 22½ lbs. treacle; 150 gallons water	Weight per acre	T. c. lb. 8 0 0	T. c. lb. 0 5 0	T. c. lb. 8 5 0	
	Per cent. to entire crop.	97·0	3·0	100·0	
	Market value	£ s. d. 15 1 5	£ s. d. —	£ s. d. 15 1 5	£ s. d. 1 8 9
(5.) Untreated	Weight per acre	T. c. lb. 6 18 64	T. c. lb. 0 7 96	T. c. lb. 7 6 48	
	Per cent. to entire crop.	94·6	5·4	100.0	
	Market value	£ s. d. 12 12 10	£ s. d. —	£ s. d. 12 12 10	

On plots 1. 2, and 4 the results showed a net gain from the treatment of *3l. 4s. 9½d.*, *7s. 3½d.*, and *19s. 10d.* per acre respectively; but on plot 3 there was a loss of *19s. 6½d.*

Gain on three plots, loss on one.

EXPERIMENTS IN IRELAND.

Experiments by Irish Land Commission.

Experiment No. VII.

EXPERIMENT No. VII.—COUNTY FERMANAGH.

Name.—A. G. WEST, Esq. Address.—Ardunshin, near Brookeboro'.

Date of first dressing.—18th July.

Appearance of crop.—A fine crop, quite free from the disease.

Weather at time of application.—Occasional light showers of rain.

Date of second dressing.—8th August.

Appearance of crop.—Quite free from the disease. The four treated plots appeared fresher and a darker green colour than the untreated plot. The previous dressing was still to be observed.

Weather at time of application.—Very fine, but windy.

Date of third dressing.—10th September.

Appearance of crop.—The untreated plot quite brown with disease, and hardly a green leaf to be seen. Treated plots growing vigorously. Here and there a few plants turning yellow from natural decay.

YIELD of POTATOES and ESTIMATED VALUE of the PRODUCE, deducting the Cost of Preventive Treatment, calculated per Statute Acre, from the Results obtained upon the Experimental Plots.

Treatment per Acre.	—	Total Sound.	Diseased.	Total Crop.	Cost of Application.
(1.) 30 lbs. copper sulphate; 15 lbs. lime; 150 gallons water	Weight per acre	T. c. lb. 10 8 24	T. c. lb. None	T. c. lb. 10 8 24	
	Per cent. to entire crop.	100·0	0·0	100·0	
	Market value	£ s. d. 19 4 4	£ s. d. —	£ s. d. 19 4 4	£ s. d. 1 7 4½
(2.) 30 lbs. copper sulphate; 15 lbs. lime; 30 lbs. treacle; 150 gallons water	Weight per acre	T. c. lb. 9 0 80	T. c. lb. None	T. c. lb. 9 0 80	
	Per cent. to entire crop.	100·0	0·0	100·0	
	Market value	£ s. d. 16 12 1	£ s. d. —	£ s. d. 16 12 1	£ s. d. 1 14 10½
(3.) 22½ lbs. copper sulphate; 7½ lbs. lime; 150 gallons water	Weight per acre	T. c. lb. 8 10 0	T. c. lb. 0 2 16	T. c. lb. 8 12 16	
	Per cent. to entire crop.	98·75	1·25	100·0	
	Market value	£ s. d. 15 8 7	£ s. d. —	£ s. d. 15 8 7	£ s. d. 1 3 1½
(4.) 22½ lbs. copper sulphate; 7½ lbs. lime; 22½ lbs. treacle; 150 gallons water	Weight per acre	T. c. lb. 8 2 96	T. c. lb. None	T. c. lb. 8 2 96	
	Per cent. to entire crop.	100·0	0·0	100·0	
	Market value	£ s. d. 3	£ s. d. —	£ s. d. 14 4 3	£ s. d. 1 8 9
(5.) Untreated	Weight per acre	T. c. lb. 6 10 0	T. c. lb. 1 0 0	T. c. lb. 7 10 0	
	Per cent. to entire crop.	86·7	13·3	100·0	
	Market value	£ s. d. 11 17 11	£ s. d. —	£ s. d. 11 17 11	

Net gain on all plots from treatment.

All the dressed plots yielded results which testified to the value of the treatment, the net gain per acre on each plot was as follows:—Plot 1, 5*l.* 19*s.* 0½*d.*; plot 2, 2*l.* 19*s.* 3½*d.*; plot 3, 2*l.* 7*s.* 6½*d.*: and plot 4, 17*s.* 7*d.*

EXPERIMENT No. VIII.—COUNTY FERMANAGH.

Name.—FRANCIS MURPHY. Address.—Tullynagowan, near Brookeboro'.

Date of first dressing.—22nd July.

Appearance of crop.—A poor crop. Quite free from disease.

Weather at time of application.—Fine.

Date of second dressing.—10th August.

Appearance of crop.—Treated and untreated plots quite free from disease. The four treated plots were of a darker green colour than the untreated plot. The previous dressing was still to be observed on the leaves.

Weather at time of application.—Fine and sunny.

Date of third dressing.—13th September.

Appearance of crop.—Not a green leaf left on the untreated plot. The four treated plots were quite green and growing vigorously.

YIELD of POTATOES and ESTIMATED VALUE of the PRODUCE, deducting the Cost of Preventive Treatment, calculated per Statute Acre, from the Results obtained upon the Experimental Plots.

Treatment, per Acre.	—	Total Sound.	Diseased.	Total Crop.	Cost of Application.
(2.) 30 lbs. copper sulphate 15 lbs. lime 30 lbs. treacle 150 gallons water	Weight per acre	T. c. lb. 5 12 16	T. c. lb. 0 0 20	T. c. lb. 5 12 36	
	Per cent. to entire crop.	99·83	·17	100·0	
	Market value	£ s. d. 10 5 9	£ s. d. —	£ s. d. 10 5 9	£ s. d. 1 14 10½
(3.) 22½ lbs. copper sulphate 7½ lbs. lime 150 gallons water	Weight per acre	T. c. lb. 4 5 0	T. c. lb. 0 1 48	T. c. lb. 4 6 48	
	Per cent. to entire crop.	98·4	1·6	100·0	
	Market value	£ s. d. 7 9 3	£ s. d. —	£ s. d. 7 9 3	£ s. d. 1 3 1½
(4.) 22½ lbs. copper sulphate 7½ lbs. lime 22½ lbs. treacle 150 gallons water	Weight per acre	T. c. lb. 5 8 64	T. c. lb. 0 0 40	T. c. lb. 5 8 104	
	Per cent. to entire crop.	99·67	·33	100·00	
	Market value	£ s. d. 9 12 10	£ s. d. —	£ s. d. 9 12 10	£ s. d. 1 8 9
(5.) Untreated	Weight per acre	T. c. lb. 3 18 64	T. c. lb. 0 10 0	T. c. lb. 4 8 64	
	Per cent. to entire crop.	88·7	11·3	100·0	
	Market value	£ s. d. 6 15 0	£ s. d. —	£ s. d. 6 15 0	

Plot 1 had been dug before Mr. West visited the farm to test results. The net gain per acre on plot 2 from the treatment was 1*l.* 15*s.* 10½*d.*; and on plot 4 there was a gain of 1*l.* 9*s.* 1*d.* But on plot 3 the results showed a loss of 8*s.* 10½*d.* per acre.

Gain on two plots, loss on one.

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EXPERIMENTS IN IRELAND.

Experiments by Irish Land Commission.

Experiment No. IX.

EXPERIMENT No. IX.—COUNTY FERMANAGH.

Name.—R. LITTLE. Address.—Tyrenny, near Brookeboro'.

Date of dressing.—25th July.

Appearance of crop.—A good healthy crop free from disease.

Weather at time of application.—Fine, sunny at times.

YIELD of POTATOES and ESTIMATED VALUE of the PRODUCE, deducting the Cost of Preventive Treatment, calculated per Statute Acre, from the Results obtained upon the Experimental Plots.

Treatment, per Acre.	—	Total Sound.	Diseased	Total Crop.	Cost of Application.
(1.) 30 lbs. copper sulphate	Weight per acre -	T. c. lb. 7 0 0	T. c. lb. None.	T. c. lb. 7 0 0	
15 lbs. lime - - -	Per cent. to entire crop.	100·0	0·0	100·0	
150 gallons water - -	Market value -	£ s. d. 12 17 1	£ s. d. —	£ s. d. 12 17 1	£ s. d. 0 9 1½
(2.) 30 lbs. copper sulphate	Weight per acre -	T. c. lb. 8 8 64	T. c. lb. None.	T. c. lb. 8 8 64	
15 lbs. lime - - -	Per cent. to entire crop.	100·0	0·0	100·0	
30 lbs. treacle - -					
150 gallons water - -	Market value -	£ s. d. 15 14 3	£ s. d. —	£ s. d. 15 14 3	£ s. d. 0 11 7½
(3.) 22½ lbs. copper sulphate	Weight per acre -	T. c. lb. 7 2 96	T. c. lb. 0 0 80	T. c. lb. 7 3 64	
7½ lbs. lime - - -	Per cent. to entire crop.	99·6	0·4	100·0	
150 gallons water - -	Market value -	£ s. d. 12 18 7	£ s. d. —	£ s. d. 12 18 7	£ s. d. 0 7 8½
(4.) 22½ lbs. copper sulphate	Weight per acre -	T. c. lb. 7 12 96	T. c. lb. 0 0 40	T. c. lb. 7 13 24	
7½ lbs. lime - - -	Per cent. to entire crop.	99·8	0·2	100·0	
22½ lbs. treacle - -					
150 gallons water - -	Market value -	£ s. d. 13 17 2	£ s. d. —	£ s. d. 13 17 2	£ s. d. 0 9 7
(5.) Untreated - - -	Weight per acre -	T. c. lb. 5 17 96	T. c. lb. 0 3 64	T. c. lb. 6 1 48	
	Per cent. to entire crop.	97·1	2·9	100·0	
	Market value -	£ s. d. 10 9 3	£ s. d. —	£ s. d. 10 9 3	

[illegible]lots [illegible]ed by [illegible]t.

All the plots benefited by the treatment. On plot 1 the net gain per acre was 1*l*. 18*s*. 8½*d*. and on plots 2, 3, and 4 the results showed a gain per acre of 4*l*. 13*s*. 4½*d*., *l*. 1*s*. 7½*d*., and 2*l*. 18*s*. 4*d*. respectively.

Experiments by Irish Land Commission.

Experiment at Westland.

EXPERIMENT carried out by MR. W. A BARNES, at Westland, Moynalty, Kells, County Meath.

MR. BARNES reported as follows:—

"The weather was very showery at the time the dressings were applied, and therefore I would not place much reliance on the comparative results between the plots dressed with and without treacle. It will be observed that one treacle plot gave the heaviest yield of the four, while the other gave the lowest, this is accounted for by a very heavy shower coming on shortly after the latter had been dressed."

YIELD of POTATOES and ESTIMATED VALUE of the PRODUCE, deducting the cost of Preventive Treatment, calculated per Statute Acre, from the results obtained upon the Experimental Plots.

Treatment per Acre.	—	Total Sound.	Diseased.	Total Crop.	Cost of Application.
(1.)					
30 lbs. copper sulphate	Weight per acre -	T. c. lb. 13 16 28	T. c. lb. 0 3 63	T. c. lb. 13 19 91	
15 lbs. lime - - -	Per cent. to entire crop.	98·7	1·3	100·0	
150 gallons water - -	Market value -	£ s. d. 26 15 9	£ s. d. 0 1 9	£ s. d. 26 17 6	£ s. d. 3 0 0
(2.)					
30 lbs. copper sulphate	Weight per acre -	T. c. lb. 12 11 28	T. c. lb. 0 3 28	T. c. lb. 12 14 56	
15 lbs. lime - - -	Per cent. to entire crop.	98·7	1·3	100·0	
30 lbs. treacle - -					
150 gallons water - -	Market value -	£ s. d. 24 8 4	£ s. d. 0 1 7	£ s. d. 24 9 11	£ s. d 3 10 0
(3.)					
22½ lbs. copper sulphate	Weight per acre -	T. c. lb. 13 18 84	T. c. lb. 0 2 88	T. c. lb. 14 1 60	
7½ lbs. lime - - -	Per cent. to entire crop.	99·0	1·0	100·0	
150 gallons water - -	Market value -	£ s. d. 27 3 5	£ s. d. 0 1 4	£ s. d. 27 4 9	£ s. d. 2 17 6
(4.)					
22½ lbs. copper sulphate	Weight per acre -	T. c. lb. 14 5 0	T. c. lb. 0 2 28	T. c. lb. 14 7 28	
7½ lbs. lime - - -	Per cent. to entire crop.	99·2	0·8	100·0	
22½ lbs. treacle - -					
150 gallons water - -	Market value -	£ s. d. 28 0 5	£ s. d. 0 1 1	£ s. d. 28 1 6	£ s. d. 3 5 0
(5.)					
	Weight per acre -	T. c. lb. 9 13 56	T. c. lb. 0 17 56	T. c. lb. 10 11 0	
Untreated - - -	Per cent. to entire crop.	91·7	8·3	100·0	
	Market value -	£ s. d. 18 9 8	£ s. d. 0 8 9	£ s. d. 18 18 5	

The results of the experiments at Westland showed a gain from the treatment on all the dressed plots. The net gain per acre in each case was as follows:—On plot 1, 4*l.* 18*s.* 1*d.*; plot 2, 2*l.* 1*s.* 6*d.*; plot 3, 5*l.* 8*s.* 10*d.*; plot 4, 5*l.* 18*s.* 1*d.*

Gain on dressed

REPORT OF EXPERIMENT conducted by the DUNGANNON BOARD OF GUARDIANS on the Workhouse Grounds at Dungannon.

Experiments by Irish Land Commission.

The following report was made by Mr. THOMAS TACKABERRY, Workhouse Master, who superintended the experiment.

"The total area of the plots treated on the workhouse grounds was about 1½ statute acres.

"The area tested by digging and weighing was 44 yards of a 27-inch drill in the dressed plot, from which was obtained 6 stone 2 lb. of marketable potatoes as compared with 4 stone 12 lbs. in the same length of an undressed drill. No notice was taken of the small or black potatoes, which were trifling in both cases. The mixture was applied once, and the time occupied was 1½ days for a man and an attendant. The crop was dressed about the middle of July, the weather being dry and warm at the time.

"The leaves and stalks of the treated potatoes continued green and healthy for about three weeks longer than those of the untreated. Taking into account the fact that the workhouse grounds are very much worn by continued cropping, I consider the result highly satisfactory."

Mixture without treacle adhered as well as that with.

So far as could be judged by the eye the mixture without treacle remained on the leaves equally as long as that to which treacle had been applied.

In every instance the foliage of the treated plots remained green for from three to five weeks longer than that of the untreated plots.

The tubers dug in the treated plots were generally larger than those in the untreated plots, and the former when cooked and eaten were found to be of better quality than the latter.

Allowing for differences in quality of soil and uneven manuring, the general results of the experiments favour the application of a 2 per cent. mixture, without treacle.

About 150 gallons per acre is sufficient to dress thoroughly an average crop of Champions with fully developed foliage, 80 to 100 gallons per acre is sufficient for a crop without much foliage. Much depends on the skill of the operator.

Experiment No. 9 tends to show that a single dressing applied at the proper time may be quite sufficient.

Potato-disease was very prevalent in every district in which the experiments were conducted.

In order to ascertain if any portion of the mixture applied had been absorbed by the leaves or stalks of the plants which had been sprayed, two samples of leaves and stalks, one of which had been treated with the sulphate of copper and lime mixture, and the other with the sulphate of copper, lime, and treacle mixture, were submitted to Sir Charles Cameron for analysis. A sample of potatoes grown on the first mentioned plot, the foliage of which was analysed, was also submitted for analysis; it will be seen from Sir Charles Cameron's report, that each sample of leaves and stalks absorbed a certain amount of copper, but that the tubers did not contain more copper than might be found in any samples of tubers, the foliage of which had not been so treated.

Tubers did not contain copper.

The very full reports supplied by Sir Charles Cameron will prove of much interest.

REPORT from Sir CHARLES A. CAMERON, M.D., D.P.H. (Cambridge), F.R.C.S.I., M.R.C.P.I., F.I.C., Medical Officer of Health for Dublin, City and County Analyst.

City Laboratory,
Municipal Buildings,
Dublin, November 25th, 1892.

Experiments by Irish Land Commission.

At the request of the Irish Land Commissioners I have carried out the following investigation:—

Sir Charles Cameron's investigation.

Specimens of (1) potato stalks, (2) potato leaves which had been treated with solution of sulphate of copper, (3) specimen of potato stalks, and (4) potato leaves which had been treated with sulphate of copper and treacle, were analysed as follows:—

300 grammes (nearly 12 ozs.) of each of the above specimens were placed in a porcelain basin under a water tap and thoroughly washed. After four days' washing it was considered impossible that the most minute trace of copper sulphate could have remained on the leaves or stalks. The washings were, towards the close of the process, tested for copper by evaporating a large quantity to a minute proportion, and applying to the latter appropriate tests which proved to be negative.

Each specimen after being washed was treated as follows:—It was dried and then burned in a large platinum dish. The specimens were at first charred, allowed to cool and their soluble constituents exhausted by treatment with distilled water. The residue of charred matter was then heated until everything organic and volatile was expelled. To prevent any copper, if present, being volatilised, the blowpipe flame was not applied to the platinum vessel, and the temperature was not raised above dull redness. A greyish ash having been obtained by the incineration of the specimens, the saline matter obtained from the charred masses was added to the grey mass, and the mixture boiled for several hours in dilute pure nitric acid. By this process it was intended to get into solution any copper that might be present in the ash.

Sulphate of copper is soluble in water, but on being calcined in contact with organic matter, the sulphate would be reduced to an insoluble sulphide, or if the temperature were very high, and organic matter present, to metal. The nitric acid solution was next filtered off the insoluble matter associated with it, and concentrated so as to get rid of most of the nitric acid. On diluting the concentrated solution with distilled water, and the addition of ammonia in excess, a bulky precipitate of the oxide of iron, phosphate of calcium, &c., took place. On the subsidence of the precipitate, a blue solution, indicative of the presence of copper, was seen. The solution obtained from the leaves was a much deeper blue than that yielded by the stalks; and the solutions obtained from the specimens treated with sulphate of copper only were of deeper hue than the corresponding solutions obtained from the specimens treated with sulphate of copper and treacle.

The amount of copper in each solution was determined by precipitating it as a sulphide, by transmitting sulphuretted hydrogen gas through the solution. It is unnecessary to mention here all the precautions necessary to be taken to ensure the accuracy of this method of determining the amount of copper in a solution; they were fully observed.

The amount of copper having been ascertained, according to the atomic laws, its equivalent as crystallized sulphate of copper ($CuSO_4$, 5 H_2 O) was calculated.

Amount of copper found in potato stalks and leaves:—

Amount of copper in stalks and leaves.

	Treated with Copper Sulphate, and Treacle, 100 parts contain—		Treacle with Copper, Sulphate, 100 parts contain—	
	Leaves.	Stalks.	Leaves.	Stalks.
Copper - - - - - -	0·0412	0·0078	0·0527	0·0128
Equal to crystallized sulphate of copper.	0·1630	0·0307	0·2082	0·0506

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The quantities of sulphate of copper absorbed by the potato leaves is very great. In those treated with sulphate of copper alone, the quantity amounts to more than two parts per thousand. The stalks have absorbed very much less than the leaves. The presence of treacle materially prevented the absorption of the copper. It is remarkable that sulphate of copper, which is a tolerably soluble salt, should so freely enter into the tissues of the potato leaves, and remain there, notwithstanding that the leaves were under a water tap for four days. No doubt, the copper became fixed or insoluble in the plants.

I mixed sulphate of copper, lime and water, in the proportions in which they were applied to the potatoes, namely, 15 parts of sulphate, 7½ of lime, and 1,500 of water. The lime is much more than sufficient to precipitate the copper, as hydroxide or hydrated oxide, the excess of lime and the hydrated oxide, precipitate, leaving sulphate of lime in solution. I found that the clear solution did not contain any copper. It is strange how the plants can absorb copper under these circumstances, the hydrated oxide being insoluble. I passed a stream of carbonic acid gas through the suspended oxide of copper, but by this treatment only a minute quantity of the copper went into solution. The rain water which falls on the potatoes contains carbonic acid, which might possibly dissolve a little of the copper oxide and convey it into the plants In some way, however, the copper finds its way into the plant, no doubt through the stomata or pores. How far it penetrates has yet to be determined. Nor can it be considered as a settled matter that the copper absorbed protects the plant from the ravages of the fungus.

Copper occurs naturally in many food substances, but only in minute quantities. Duclaux states that he detected in 1,000 parts of cocoa-beans from 0·009 to 0·04 of copper, and in 1,000 parts of the outer shell, from 0·035 to 0·225 of copper. These are small quantities when compared with the amounts which I have found in the potato leaves.

(Signed) CHARLES A. CAMERON,
Professor of Chemistry, R.C.S.I., Lecturer
on Agricultural Chemistry and Geology,
Glasnevin Government Farm.

Department of the Medical Officer of Health and Public Analyst.

Public Health Office, Cork Hill, City Laboratory,
17, Castle Street, Dublin,
December 21, 1892.

Only infinitesimal trace of copper in tubers.

SIR,—I beg to inform you that I have examined for the presence of copper the potatoes which you sent to me for that purpose. I found that using 300 grammes weight of potatoes an almost infinitesimal trace of copper was detected. The quantity found was unweighable, and might have occurred in potatoes not specially treated with sulphate of copper. A much larger amount would be in no wise injurious to health.

I am, Sir,
Your obedient Servant,
(Signed) CHARLES A. CAMERON.

The Secretary,
Irish Land Commission.

Further experiments needed to determine certain points.

In his comments on the above experiments Mr. Franks, Secretary of the Irish Land Commission, states that it appears to be desirable that further experiments should be carried out to obtain information with respect to the following points which are of considerable importance to the practical agriculturist, viz :—

(1.) Should the potato plant be sprayed from above only, from below only, or both from above and below ?

(2.) Is it sufficient to thoroughly spray the potato plant once only, provided that the dressing be applied when the foliage is fully developed, and immediately before the earliest period at which the disease may be expected in the locality?

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(3.) How and in what form does the copper contained in the dressing find its way into the tissues of the foliage, and what length of time must elapse after the application of the dessing, in order that the copper may find its way into the tissues of the foliage to any considerable extent?

(4) Is the potato plant rendered practically disease-proof by the absorption of copper by the tissues of the leaf, even though the rain may have removed all traces of the dressing from the surface of the leaves?

The following is a copy of a circular issued by the Agricultural Department of the Irish Land Commission in June 1893:—

POTATO DISEASE.

Instructions for the Application of Sulphate of Copper and Lime Mixture to the Potato Plant for the prevention of Potato-Disease by the means of "Knapsack Sprayers."

Dates and mode of applying dressings.

1. The dressing should be applied about a fortnight before the earliest period at which disease has been known to make its appearance in the locality; the period of application in Ireland would therefore vary from the beginning of June in early districts to the latter end of July in late districts.

2. The dressing should be applied by means of a spraying machine, specially constructed for the purpose of throwing a fine mist-like spray, with which the foliage of the potato plant should be covered. Many spraying machines are sold, suitable for horse and hand power; the "Strawson" and "Éclair" knapsack sprayers, costing 35*s.* each, have proved very satisfactory; they can be worked by one man, and can be procured through any dealer in agricultural implements. Knapsack sprayers are the most suitable for use on small areas; the following instructions have been prepared on the assumption that such sprayers will be used.

PREPARATION OF THE MIXTURE.

Instructions for preparing dressings.

3. To prepare 25 gallons of the mixture, the quantity which one man can apply to an ordinary crop in three hours with a knapsack sprayer:—

(*a.*) Put twenty gallons of cold water into a wooden tub or cask, an empty paraffin barrel, with the head taken off, will suit admirably, and put five gallons of cold water into another vessel.

(*b.*) Take five pounds of powdered copper sulphate (if the copper sulphate is not powdered break it fine with a hammer); put the copper sulphate into a piece of coarse sacking, and suspend the sacking in the vessel containing 20 gallons of water so that the copper sulphate may readily dissolve in the water; the powdered copper sulphate should dissolve in about fifteen minutes; it may be stirred frequently to promote dissolution.

(*c.*) Put 2½ lbs. of freshly burned, pure, unslaked lime into a vessel, add sufficient water thereto from the vessel containing five gallons of water, to slake the lime; when the lime is thoroughly slaked add enough water from the five-gallon vessel to thoroughly cool the

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lime, thus producing a thin milk of lime, then pour any water remaining in the five-gallon vessel into the 20-gallon vessel containing the copper sulphate.

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(*d.*) When the copper sulphate has been completely dissolved, stir it well with a stick and then pour the milk of lime slowly into the copper sulphate solution, stirring the whole continuously, and continue stirring for five minutes; the mixture should then appear azure-blue in colour; the mixture should then be allowed to rest for five minutes; after resting for five minutes the liquid should appear perfectly clear for a few inches in depth, the clearness of the liquid can be tested by holding a piece of white paper a few inches below the surface; if instead of appearing clear the liquid to the depth mentioned is slightly tinged with blue, slack four ounces of lime as before, add it to the mixture and stir thoroughly again, repeating this process if necessary until the upper portion of the liquid appears clear after having been allowed to rest for a few minutes, the mixture being then ready for use.

Proportions of ingredients.

4. Prepare whatever quantity of the above mixture may be required, using the ingredients in the following proportions, namely:—

20 lbs. of copper sulphate.
10 lbs. of lime.
100 gallons of water.

The copper sulphate may be left in solution for a considerable period, but the lime water should be freshly made and added to the copper sulphate solution immediately before use.

APPLICATION.

Application.

5. Stir the mixture thoroughly, then fill the cylinder of the knapsack sprayer, using a wooden or copper vessel for the purpose; the operator should then strap the machine on his back, and proceed to dress the crop, working the sprayer according to the directions sent out with each machine: the operator should walk slowly between the drills or lazy beds, and thoroughly spray the plants on each side from below and from above, pumping with one hand so as to maintain a steady pressure, and directing the nozzle with the other hand so as to throw the spray over every portion of the plants; if the foliage is very rank, meeting across the drills, the operator should walk backwards to avoid brushing the mixture off the plants with his clothes.

Important matters to be attended to.

6. *Important matters to be attended to:—*

1. Spray during dry weather, so that the mixture may remain on the foliage; if heavy rain falls within six hours after spraying, it would be desirable to spray again on the first favourable opportunity.
2. Use only pure copper sulphate, guaranteed to be of 98 per cent. purity; buy it powdered, or powder it before use; ordinary commercial sulphate of copper contains a large amount of sulphate of iron, and should not be used. Pure copper sulphate costs about 3*s.* per stone when purchased in small quantities, and can be obtained from the leading druggists.
3. If the sulphate of copper is impure, and contains much sulphate of iron, the mixture when prepared will appear greenish or brownish, instead of being deep azure-blue in colour.
4. Take care that the lime used is pure, well burnt, and unslacked.
5. Cold water should invariably be used in preparing the mixture; hot water should not be used. The lime, after being slacked, should be quite cool before being added to the copper sulphate solution; it may be cooled by adding cold water.

6. Iron vessels should not be used in preparing or handling the mixture, wooden or copper vessels should be used for such purposes.

Experiments by Irish Land Commission.

7. Empty paraffin barrels have been found very suitable for the preparation of the mixture; it will generally be found most convenient to prepare the mixture in the field in which it is to be used.

8. The mixture should be well stirred with a stick or piece of wood on each occasion before a fresh supply is drawn for the spraying machines.

9. The spraying machines should be oiled before being used: as there is a good deal of india-rubber in the working parts of the "Éclair," pure olive oil should be used for lubricating: ordinary machine oil should be avoided, as it frequently contains paraffin, which dissolves india-rubber.

10. One man attended by a boy can apply about nine or ten gallons of dressing with a knapsack spraying machine in one hour. One boy can attend three men using knapsack sprayers, carrying fresh supplies of dressing to them.

Quantity of dressing per acre.

11. The quantity of the mixture to be applied per acre is approximately as follows—the mixture when prepared costing about one halfpenny per gallon:—

	Per Statute Acre.	Per Irish Acre.
For an average crop of Champions with fully developed foliage	100 gallons	160 gallons
For a crop of Champions with more than the average amount of foliage	150 gallons	240 gallons
For a crop of Champions with a small development of foliage	80 gallons	130 gallons

12. When dressing potato plants which are very young, or of tender-leaved varieties, it would be desirable to weaken the mixture by the addition of one-third more water than the quantity specified in the instructions given above.

13. Sulphate of copper being a poison, the vessels in which the mixture is prepared should not afterwards be used for holding food or drink for animals.

EXPERIMENTS CARRIED OUT BY THE AGRICULTURAL DEPARTMENT OF THE COMMISSIONERS OF NATIONAL EDUCATION, IRELAND.

Experiments by Commissioners of National Education, Ireland.

The experiments upon the potato which were carried out at the Albert Farm, Glasnevin, under the direction of the Agricultural Department of the Commissioners of National Education of Ireland in 1892, had for their object:—

1. Investigation as to the mode by which the disease *phytophthora infestans* reaches the tuber of the potato plant.
2. Measures for the prevention of, or for the lessening of the effects of the disease upon the crop.

EXPERIMENTS IN IRELAND.

Experiments by Commissioners of National Education.

Mr. Carroll states that in reports which he has previously written upon experiments made for testing preventives against disease, he has endeavoured to show that further investigation is desirable to ascertain by what means "the disease" is propagated, and he has to repeat his opinion that until exact knowledge of the life history of the *Phytophthora* is obtained, we shall continue to be working in the dark in trying remedial measures.

The "search light of science," he says, "is necessary to guide "practice in dealing with the important, but difficult question of "the proper mode of prevention of disease."

With the view towards helping on inquiry as to the means by which the potato tubers become affected by disease, the following experiments were carried out under the superintendence of Mr. Carroll at the Albert Farm, Glasnevin, and at the Garryhill Agricultural National School, county Carlow.

The point upon which light was sought was as to whether the disease-producing mycelium reached the tubers of the potato plant through the aerial and underground stems, or by means of the disease-producing spores falling upon the earth, and being washed through it to the surface of the tubers.

Mr. Carroll remarks, that for a long period he has inclined to the view held by those who support the theory that the disease reaches the tubers from without, *i.e.*, that the spores reach the immature tubers through being carried to them through the earth by water, and amongst the different theories propounded on this subject, he has already on different occasions felt constrained to express this opinion.

1. *Experiments as to the Propagation of the Potato-Disease.*

Experiments by Mr. Carroll as to propagation of the disease.

Mr. Carroll states that the experiments here noted are submitted with a due regard to the consideration that should be accorded to those who have given so much attention to plant diseases. He does not offer them as anything approaching a final solution of the question involved, nor does he claim for them any position but that of an *attempt* at investigation.

The experiment was carried out at the two stations upon similar lines, and at each place the Flounder, a variety of potato extremely liable to disease, was chosen for the experiment.

A portion of ground upon which these potatoes were growing was covered beneath the potato stems and leaves with a layer of cotton wool. This cotton wool was carefully placed around the stems, and every means was used to have the ground perfectly covered with it with the view of filtering out the spores that might fall upon the ground.

The cotton wool was put on in June, before any sign of disease was noticeable. Disease appeared in July, and the leaves of the potato plants were in each case badly affected.

Upon raising the potatoes in October, the following results were noticed:—

Experiments by Commissioners of National Education.

Results.

Albert Farm, Glasnevin.

Potatoes where ground was covered with cotton wool:—
Sound potatoes - - - 75 tubers.
Diseased - - - —

Potatoes where ground was uncovered:—
Sound potatoes - - - 40 tubers.
Diseased - - - 33 „

Garryhill Agricultural National School.

Potatoes where ground was covered with cotton wool:—
Sound tubers - - - - 95
Diseased - - - - - —

Potatoes where ground was uncovered:—
Sound tubers - - - - 61
Diseased - - - - - 15

These experiments, which were very carefully carried out, serve to indicate that the disease is carried to the tubers of the potato plant through the spores, which cause the disease, being taken through the earth to the tuber, and not by means of the mycelium finding its way to the tubers through the stem of the plant.

These experiments will be repeated in 1893.

2. The Sulphate of Copper Remedy against Potato-Disease.

Experiments with sulphate of copper.

Experiments similar to those of last year, on the use of sulphate of copper as a preventive of potato-disease, were carried out at the following stations:—

The Albert Farm, Glasnevin.
The Munster Agricultural School, Cork.
The Garryhill Agricultural National School, co. Carlow.
The Woodstock Agricultural National School, co. Kilkenny.

On the whole, it is stated, the details of these experiments serve to show that the judicious use of a solution of copper will very sensibly minimise the effects of the disease.

It appears that the success of the application of this remedy against potato-disease depends very materially upon—

(*a*) the remedy being applied at the proper time;
(*b*) the thoroughness of the dressing;
(*c*) the atmospheric conditions at the time of the application.

As regards the period at which the dressing, the composition of which is now generally known, should be applied, Mr. Carroll has frequently expressed the view that the disease once set in cannot be cured, and that the discovery of M. Girard must be relied upon solely as a preventive and not as a curative agent.

Experience of the use of these remedies during the past few years has, he considers, borne out this view.

Experiments by Commissioners of National Education.

He observes that it is probable that the film of copper solution which covers the leaves and stems of the potato causes the death of the disease-producing spores when they reach the leaves and stems, and that if it were possible to thoroughly coat over all parts of the potato plants with a film of this mixture the disease would be entirely prevented. He does not think that any experiment has shown that the copper solution can reach the mycelium within the plant structure. Indeed, he considers that the stage when the mycelium has formed within the tissues of the plant is a period almost too late for remedial measures.

Mr. Carroll points out that if these views be correct, then it follows that the preventive dressings should be applied some time previously to the appearance of the disease, and that every effort should be made to thoroughly coat over the potato plants; and as regards the atmospheric conditions, it follows that if rain should interfere with the dressing, further applications should be made until the plants retain the necessary coating of the dressing of hydrated oxide of copper.

Expense of dressings must be lessened.

In his concluding remarks Mr. Carroll states that, if further experience in the use of these copper dressings proves their effectiveness, some means must be found for lessening expense in their use.

An experiment, having for its object the testing of the effect of removing the stalks of potatoes upon the appearance of disease with the view of preventing the tubers from being affected, was carried out at the Ballacutranta School Farm, Co. Sligo.

Removal of potato haulm to prevent disease.

The system of removing the potato haulm upon the appearance of the disease has frequently been recommended as a preventive.

During the month of August the potato-disease was fairly active in the County Sligo; and in this month at the Ballacutranta Agricultural National School, two plots of ground bearing a crop of potatoes were marked out for experiment. On one the stalks were removed. On the other they were allowed to remain.

Early in November the potatoes were lifted, and the weights were found to be as follows:—

Crop where stalks were removed, 58 lbs.
Crop where stalks were not removed, 73½ lbs.

The amount of diseased tubers was practically the same in both cases.

Where stalks were removed, 6½ lbs.
Stalks not removed, 6 lbs.

Benefit by removal of

This experiment, it is remarked, serves to show that, through the removal of the potato haulm before the crop was matured, the

yield of crop was lessened without commensurate benefit in freedom from disease.

Experiments by Commissioners of National Education.

Experiments at the Albert Model Farm, Glasnevin.

For the purpose of this experiment a field was taken in which were growing three varieties of potatoes.

Dressings used at Albert Model Farm.

The following dressings were applied on 14th July :—

Dressing No. 1, 5 lbs. sulphate of copper.
5 lbs. quick lime.
5 lbs. treacle.
25 gallons water.
(For one rood.)

Dressing No. 2, 5 lbs. sulphate of copper.
5 lbs. quick lime.
25 gallons water.
(For one rood.)

Dressing No. 3, 11 lbs. sulphate of copper.
5½ lbs. quick lime.
25 gallons water.
(For one rood.)

Dressing No. 4, 5½ lbs. sulphate of copper.
2¾ lbs. quick lime.
27½ gallons water.
(For one rood.)

The mode of application of these mixtures known as bouillie bordelaise, was by the sprayers, Éclair and Pilter-Bourdil,' the former by far the better machine for the purpose.

Results of treatment.

The potatoes were raised on 6th October, and the following table shows the result:—

Variety.	Dressing No. 1.		Dressing No. 2.	
	Sound.	Diseased.	Sound.	Diseased.
Champion	T. c. q. lbs. 11 3 0 23	T. c. q. lbs. 1 0 1 3	T. c. q. lbs. 10 13 1 27	Nil.
Percentage	91·7	8·3	—	—
Irish Whites	3 0 3 14	Nil.	5 8 0 25	Nil.
Percentage	—	—	—	—
Bruce	11 9 3 25	Nil.	10 16 1 27	Nil.
Percentage	—	—	—	—
Average per acre	8 11 1 11	Nil.	9 0 1 9⅓	Nil.
Percentage of disease	—	9·68	—	3·12

EXPERIMENTS IN IRELAND.

Experiments by Commissioners of National Education.

Variety.	Dressing No. 3.		Dressing No. 4.		No Dressing.	
	Sound.	Diseased.	Sound.	Diseased.	Sound.	Diseased.
Champion -	T. c. q. lbs. 10 16 1 27	T. c. q. lbs. 0 6 3 1	T. c. q. lbs. 8 15 3 10	Nil.	T. c. q. lbs. 10 16 2 9	Nil.
Percentage -	97·0	3·0	—	—	—	—
Irish Whites -	3 14 1 17	Nil.	3 6 3 14	Nil.	5 8 1 13	Nil.
Percentage -	—	—	—	—	—	—
Bruce -	10 19 3 13	Nil.	4 1 0 18	Nil.	9 19 2 4	Nil.
Percentage -	—	—	—	—	—	—
Average per acre	8 10 1 0⅔	Nil.	5 5 3 23⅓	Nil.	8 18 0 18	Nil.
Percentage of disease.	—	—	—	—	—	—

EXPERIMENT No. 2.

Result of experiment on variety liable to disease.

This experiment was carried out with a view of testing the efficacy of sulphate of copper in saving from disease a variety of potatoes (Kemps) extensively grown in this country, and liable to disease.

Ten drills, 21 feet long and 28 inches wide, were selected for the purpose and dressed with mixtures similar to those applied on the farm and numbered 1, 2, 3, and 4.

The dressing was applied on 15th July and the crop was raised on the 6th October 1892.

Variety.	Dressing No. 1.		Dressing No. 2.		Dressing No. 3.		Dressing No. 4.		No Dressing.	
	Sound.	Diseased.	Sound.	Diseased.	Sound.	Diseased.	Sound.	Diseased.	Sound.	Diseased.
Kemp (early Scotch).	St. lb. 3 5	St. lb. 2 1	St. lb. 3 1	St. lb. 2 2	St. lb. 4 1	St. lb. 1 8	St. lb. 3 13	St. lb. 1 10	St. lb. 2 2	St. lb. 3 3
Percentage diseased.	—	38·13	—	41·09	—	27·84	—	30·38	—	60·0

Experiments at the Munster Agricultural School, Cork.

Experiments at Munster Agricultural School.

The solutions used in these experiments were:—

(1.) 20 lbs. sulphate of copper per acre.
20 lbs. quick lime per acre.
100 gallons water per acre.
20 lbs. treacle per acre.

(2.) As above without treacle.

(3.) 44 lbs. sulphate of copper per acre.
22 lbs. quick lime per acre.
220 gallons water per acre.

(4.) 6 lbs. sulphate of copper per acre.
6 lbs. quick lime per acre.
100 gallons water per acre.

Experiments by Commissioners of National Education.

Three sets of plots A, B, C, were dressed, 12 in all, A and B merely duplicates; on the C plots the dressing was repeated after 10 days. When the solutions were sprayed over the crop on the 19th July, there was just perceptible on the foliage a few small spots of disease. It made little progress over the crop until rain set in on the 6th August. Then it spread rapidly blackening the foliage, but not so quickly on the dressed plots. However, the decay was not arrested so long as to influence the amount of the crop. Each plot for comparison was $\frac{1}{56}$ acre, an equal space undressed was left beside each plot for comparison. As shown in the following table the dressing appears to have been at least slightly effective in each case. No doubt a dressing before the appearance of the disease would tell better, or perhaps in larger plots; for the tubers on the dressed plots were quite accesible to the spores from the undressed foliage on each side. The experiment was tried only on the Champion variety.

Results at Munster School.

The results are as follows:—

	Dressed Plots.		Undressed Plots.	
	Cwts. per Acre.		Cwts. per Acre.	
	Sound.	Diseased.	Sound.	Diseased.
A Set.				
Solution No. 1 - -	193	12	199	15
Per-centage -	94·1	5·9	92·9	7·1
Solution No. 2 - -	193	10	205	18
Per-centage -	95·0	5·0	91·9	8·1
Solution No. 3 - -	211	22	203	27
Per-centage -	90·5	9·5	88·3	11·7
Solution No. 4 - -	169	8	193	11
Per-centage -	95·5	4·5	94·6	5·4
Average - -	93·78	6·22	91·9	8·1
B Set.				
Solution No. 1 - -	208	9	157	21
Per-centage -	95·8	4·2	88·2	11·8
Solution No. 2 - -	160	16	187	21
Per-centage -	90·9	9·1	89·9	10·1
Solution No. 3 - -	174	15	138	13
Per-centage -	92·1	7·9	91·4	8·6
Solution No. 4 - -	174	12	155	18
Per-centage -	93·5	6·5	89·6	10·4
Average - -	93·1	6·9	89·8	10·2

EXPERIMENTS IN IRELAND.

Experiments by Commissioners of National Education.

	Dressed Plots.		Undressed Plots.	
	Cwts. per Acre.		Cwts. per Acre.	
	Sound.	Diseased.	Sound.	Diseased.
C Set.				
Solution No. 1 - -	188	11	179	20
Per-centage -	94·5	5·5	90·0	10·0
Solution No. 2 - -	170	16	148	22
Per-centage -	91·4	8·6	87·2	12·8
Solution No. 3 - -	164	17	152	35
Per-centage -	90·6	9·4	81·3	18·7
Solution No. 4 - -	193	17	188	24
Per-centage -	91·9	8·1	88·7	11·3
Average - -	92·1	7·9	86·8	13·2

From this table it appears the second dressing had an appreciable effect, as on the C plot the per-centage of the crop saved by the dressings was 5·3, and on the A and B plot dressed once it was 2·6.

The following table shows the average per-centage of the three plots to which each solution was applied, and for the adjoining undressed plots:—

	Dressed.		Not Dressed.		Difference.
	Sound.	Diseased.	Sound.	Diseased.	
Solution No. 1 -	94·8	5·2	90·4	9·6	4·4
„ „ 2 - -	93·3	6·7	89·6	10·4	3·7
„ „ 3 -	91·1	8·9	87·0	13·0	4·1
„ „ 4 - -	92·8	7·2	91·1	8·9	1·7
Average -	93·0	7·0	89·5	10·5	3·5

It is remarked that though a conclusion cannot safely be drawn in the absence of more decisive results, it may be noted that solutions (1) and (3) appear equally effective, while (4) appears insufficient.

Experiments at the Garryhill Agricultural N. School, County Carlow.

Experiments at Garryhill Agricultural N.

The potato crop on this farm in 1892 was subjected to dressings of sulphate of copper and lime. The results bear out the conclusions of previous years, viz., that the application is ineffective

in preventing the disease reaching the tubers, but as it keeps the plants growing for a fortnight after the disease has killed those undressed it is highly beneficial in increasing the weight of produce. As the tubers have thus time to mature it is very probable that their nutritive qualities are also improved.

Experiments by Commissioners of National Education.

One dressing (No. 1) consisted of a mixture of 44 lbs. sulphate of copper, 22 lbs. lime and 220 gallons of water per acre.

No. 2 dressing consisted of a mixture of 20 lbs. sulphate of copper, 20 lbs. lime, and 100 gallons water, per acre.

Separate plots were treated, and the application was made on 23rd July 1892. The following are the results:—

	Total Produce per Acre.		Diseased.	
	Tons.	Cwts.	Cwts.	Qrs.
No. 1 dressing	15	8	15	2
Percentage diseased	—		5	
No. 2 dressing	14	12	10	1
Percentage diseased	—		3·5	
Undressed plot	12	11	10	1
Percentage diseased	—		4	

Another plot in which treacle was employed in the mixture shows nothing special in favour of its use.

By direction of Mr. Carroll a thick layer of cotton wool was so placed as to completely cover the earth without checking the growth of the plants which were brought through openings in the cotton wool.

When digging out, 95 tubers were found in the drills so treated, all sound. A similar length of drills in same plot was then dug with the result that of 76 tubers, 15 were diseased. This, it is observed, seems to support the theory that the disease is carried down by rain to the tubers, the spores having fallen off the leaves, and not, as generally believed, that the disease is brought down through the stalk. It points to the advantage of high moulding, a layer of earth of sufficient thickness to filter the rain water, as it descends through the earth, being apparently what is required to protect the tubers.

Experiments at the Woodstock Agricultural N. School, County Kilkenny.

Experiments at Woodstock Agricultural School.

The following dressings were applied on 18th July 1892:—

Dressing No. 1.—5 lbs. sulphate of copper
5 „ quicklime
5 „ treacle
25 gallons of water
} Per rood.

Dressing No. 2.—5 lbs. sulphate of copper
5 „ quicklime
25 gallons of water
} „

Experiments by Commissioners of National Education.

Dressing No. 3.—11 lbs. sulphate of copper -
5½ „ quicklime - -
55 gallons of water - } Per rood.

Dressing No. 4.—5½ lbs. sulphate of copper -
2¾ „ quicklime - -
27½ gallons of water - } „

The potatoes were raised on 10th October, and the following table shows the result:—

Dressing No. 1.			Dressing No. 2.		
Marketable.	Small.	Diseased.	Marketable.	Small.	Diseased.
T. c.	T. c.	T. c.	T. c.	T. c.	T. c.
9 10	0 13	0 7	8 12	0 15	0 13
Percentage diseased, 3·4.			Percentage diseased, 6·4.		

Dressing No. 3.			Dressing No. 4.			No Dressing.		
Marketable.	Small.	Diseased.	Marketable.	Small.	Diseased.	Marketable.	Small.	Diseased.
T. c.	T. c.	T. c.	T. c.	T. c.	T. c.	T. c.	T. c.	T. c.
9 6	1 3	0 6	9 0	0 17½	0 11¾	8 0	1 5	0 15
Percentage diseased, 2·8.			Percentage diseased, 5·6.			Percentage diseased, 7·5.		

It appears that all the above mixtures are decidedly beneficial. In comparing this year's (1892) experiment with that of last year, it should be noted that last year's dressing was not applied until four days after the crop had been attacked by the blight, while this year the crop was quite unblighted at the date of dressing.

In 1891 the difference in colour between the dressed and undressed portions of the crop was not quite discernible; but in 1892 this difference was marked, and held up to the date of lifting.

PART II.

EXPERIMENTS

IN

CHECKING POTATO DISEASE

IN

FOREIGN COUNTRIES.

PART II.

Experiments in Checking Potato Disease in Foreign Countries.

BELGIUM.

M. Petermann's experiments.

Experiments at Gembloux.

The Board have received the detailed report of the results of M. Petermann's experiments at Gembloux in 1891, of which a short summary was published in their Report on Experiments in Checking Potato-disease, 1892, (C. 6647). These experiments were devised to ascertain the most suitable period for applying the preventive and curative treatment with copper dressings, and to determine the value of the bouillie with an iron base, and the dressing known as sulpho-sucrate of copper.

The experiments were conducted on a field with a deep sandy soil in good tilth parcelled out into plots of 11·96 square yards separated by a space of 7·75 square inches. All the experiments were made in duplicate. The manure consisted of about 176 lbs. of nitrate of soda, 440 lbs. of dephosphorated scoria, and 440 lbs. of kainit, per acre. Whole tubers of a variety known as Jeffe were used as seed, the average weight being 2·54 ozs.

The seed was planted on 8th May and the plants began to rise in due course. The bouillie bordelaise was applied in the form of 44 lbs. of crystalised sulphate of copper, 22 lbs. of quicklime, and 220 gallons of water per acre. The sulpho-sucrate of copper of M. Perret was used in the following proportions:—44 lbs. of sulphate of copper, 88 lbs. of lime in form of thin paste, 44 lbs. of molasses and 220 gallons of water per acre.

The lime and molasses were first diluted in four-fifths of the total quantity of water, and to this mixture was added the sulphate of copper which was first partly dissolved in the remaining one-fifth of the water.

The latter preparation is more viscous than the ordinary dressings. This causes a better suspension of the precipitate, which renders unnecessary the constant stirring of the liquid, and ensures a closer and more protracted adhesion to the leaves.

The first or preventive application of the dressings was made on 10th July.

BELGIUM.

M. Petermann's experiments.

On July 16th the first signs of the disease were apparent. The curative application was carried out on July 18th.

The excessively wet weather (the rain-gauge of the agricultural station registered from 10th July to 22nd September 5·7 inches of rain) which prevailed in the summer of 1891, provoked a rapid development of the disease.

By the middle of August the plots which had not been treated exhibited symptoms of a violent attack of the disease, while those which had been treated, especially those dressed with the sulpho-sucrated bouillie, could be distinguished from afar by their greenness.

An interval of dry weather from 4th to 14th of September somewhat arrested the ravages of the *phytophthora*.

Results.

The potatoes were harvested on the 22nd of September, and the average results per acre were as under :—

	Total yield per Acre.	Tubers.	
		Sound.	Diseased.
	Tons.	Tons.	Tons.
Control plot, no treatment - -	9·1017	7·2925	1·8092
Bouillie bordelaise curative treatment -	10·4139	8·9685	1·4454
Bouillie bordelaise half preventive, half curative.	11·0283	8·6743	2·3540
Sulpho-sucrate of copper curative* -	10·2887	9·4795	0·8092
Sulpho-sucrate of copper, half curative, half preventive.	10·6326	9·1852	1·4474

* Sulpho-sucrate of copper is a mixture of molasses, lime, and sulphate of copper.

Effect on starch in tubers.

The richness in starch of the seed tubers was 19 per cent., but the potatoes harvested did not reach this standard, nevertheless those from the treated plots were richer than those from the untreated plot, as will be seen from the following statement of the percentage of starch :—

	Per cent.
Bouillie bordelaise :—	
Curative treatment - - -	17·5
Half curative treatment, half preventive -	17·5
Sulpho-sucrate of copper :—	
Curative treatment - - - -	18·3
Half curative treatment, half preventive -	18·4
Control plot - - - -	16·8

On examining the foregoing table, it will be observed that the application of the copper dressings had a significant effect on the total yield of tubers (healthy and diseased). The increase in the

M. Petermann's experiments.

gross yield from the plots dressed with bouillie bordelaise and sulpho-sucrate of copper, respectively compared with the crop from the untreated or control plot, is shown below.

	Tons.
Bouillie bordelaise :—	
Curative treatment - - - -	1·3122
Half curative treatment, half preventive -	1·9266
Sulpho-sucrate of copper :—	
Curative treatment - - - -	1·1870
Half curative treatment, half preventive -	1·5309

M. Petermann remarks that it cannot for a moment be admitted that this augmentation of the crop is due to the fertilizing action of the lime or the sulphate of copper, which had acted in the soil as the agents of diffusion or of absorption of the carbonate of ammonia of the atmosphere, but it is to be explained solely by the more complete and prolonged preservation of the leaves, the organs of evaporation, a feature which he has observed throughout his three years' experiments.

Injurious effects of fungus exhibited in two ways.

He points out that it is known that the injurious effects of the *phytophthora* are exhibited in two ways (*a*) by a diminution of the production of organic substances by the destruction of the leaves, (*b*) by the infection of the tubers, by spores falling upon the soil, or by the mycelium spreading in the interior of the plant. Consequently, the salts of copper in destroying the fungus, or at least diminishing the vitality, exercise a beneficial influence, not only reducing the risk of infection of the tubers, but also in prolonging the duration of activity of the chlorophyll.

M. Petermann says, that on examining under a magnifying glass leaves freshly attacked with the disease, it is seen in a hot and humid season how rapid is the extension from the first point of attack, which is soon followed by the complete invasion of the whole leaf, together with the destruction of the cellular tissue and the disappearance of the chlorophyll.

While, on the other hand, by carefully raising with the aid of slightly acidulated water, the coating of hydrated oxide of copper from a leaf which has been properly treated, the disease is found to be arrested at the centre of attack, and the remainder of the leaf is perfectly sound. A microscopical examination of the portion attacked shows that the fresh formation of spores has entirely ceased.

He adds that the prolongation of functions of the chlorophyll is manifested not only by the increase of the yield, but also by an augmentation of the richness in starch. The same fact was observed in 1891 by M. De Vuyst at Borsbeke-lez-Alost, who found the average richness in starch of 17 varieties on the dressed plots to be 17·05 per cent., while on the untreated plots it was 15·9 per cent.

Considering the results of his experiments from a purely practical point of view, M. Petermann states that the proper

BELGIUM.

M. Petermann's experiments.

application of copper dressings represents a considerable profit per acre in years when the disease is prevalent, as shown below.

Results.

Average results of two Experiments.

	Yield of Healthy Tubers.	Value of Crop at 48/10 per ton.	Gross Profit.	Expenses of Treatment.	Net Profit.
	Tons.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Control plot - -	7·2925	17 16 1	—	—	—
Bouillie bordelaise* -	8·8214	21 10 9	3 14 8	0 14 7	3 0 1
Sulpho-sucrate of copper.*	9·3323	22 15 9	4 19 8	0 16 2	4 3 6

* Average of two modes of application.

As in preceding years attempts were made to discover traces of copper in the parings and the flesh of washed tubers which had been taken from plots submitted to the copper treatment, and many other samples sent to Dr. Petermann were similarly examined, but the results were negative in all cases.

Dr. Petermann's conclusions.

Dr. Petermann's conclusions from the experiment carried out at the agricultural station at Gembloux during 1889, 1890, and 1891, are as follows:—

The treatment with bouillie bordelaise (ordinary) or of bouillie with molasses, constitutes an efficacious procedure for the material reduction of the injurious effects caused by the *phytophthora*.

The beneficial action of the remedy is manifested not only by an increase of the entire yield and of the yield of healthy tubers, but also by an increase of starch.

The treatment is practical and produces a much more beneficial result when it is applied to varieties more subject to disease, and under meteorological conditions of humidity and heat more favourable to the development of the parasite.

Washed tubers are free from copper.

The curative treatment applied at the moment when the disease first manifested itself has proved superior to the preventive treatment, that is to say, to the treatment carried out before the disease has appeared.

Nevertheless in practice, the half preventive, half curative treatment is recommended because the determination of the period of the first outbreak of disease demands continuous supervision and much experience, and it is more difficult to determine upon a large area.

EXPERIMENTS IN THE CAMPINE DISTRICT.

Experiments in Campine district.

In the Belgian "Bulletin de l'Agriculture," 1892 (Vol. VIII.), No. 1, there is a report of experiments in the Campine District to observe the efficacy of bouillie bordelaise and sulpho-steatite of copper on the potato-disease, from which the following notes have been taken :—

1. An experimental field was selected at Neeroeteren. The first application of bouillie bordelaise and sulpho-steatite of copper was made on the 29th June, and the second on the 1st August. The bouillie used was of the ordinary strength.

The sulpho-steatite was applied by means of bellows at the rate of 26¾ lbs. per acre. The varieties of potatoes treated were the Red of Campine and the Rykmakers, the first of which was not attacked by the disease. The following table shows the results obtained as regards the Rykmakers variety :—

Rykmakers Variety.	Control Plot (3·9 perches).	Plot dressed with Bouillie Bordelaise (3·9 perches).	Control Plot (3·9 perches).	Plot dressed with Sulpho-steatite of copper (3·9 perches).	Control Plot (3·9 perches).
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Healthy tubers -	480	539	519	563	585
Diseased tubers -	13	22	22	13	17

From these figures the effect appears to have been nil. The only conclusion that can be drawn is that the bouillie bordelaise or sulpho-steatite treatment did not diminish the yield.

Effects "Nil."

2. A second experimental field was established at Vieux-Joncs in a clayey soil. The first treatment was made on the 27th June, the second on the 30th July. The varieties experimented on were the "My Lord" and the "Saxony."

The results obtained are shown in the following table :—

	Control Plot (3·9 perches).	Plot dressed with Bouillie Bordelaise (3·9 perches).	Plot dressed with Sulpho-steatite of copper (3·9 perches).
	Lbs.	Lbs.	Lbs.
My Lord { Healthy tubers -	460	411	414
My Lord { Diseased tubers -	8·8	6·6	4·4
Saxony - { Healthy tubers -	475	479	484
Saxony - { Diseased tubers -	31	35	20

BELGIUM.

Experiments in Campine district.

In the experiment with the "My Lord" variety, the plots treated with bouillie bordelaise and sulpho-steatite yielded less diseased tubers than the control plot, but this plot gave a larger yield of healthy potatoes than the others.

In the experiment with the "Saxony" the first plot gave less diseased tubers than the second, whilst the latter gave a larger yield of sound tubers. The third plot gave the largest yield of healthy and the least of diseased tubers.

3. A third field was established at Bree. The potatoes were first treated on the 30th June, and again on the 7th August. The varieties planted were the "Red of Campine" and the "Rykmakers." The results were as follows:—

		Control Plot (3·9 perches).	Bouillie Bordelaise Plot (3·9 perches).	Sulpho-steatite Plot (3·9 perches).
		Lbs.	Lbs.	Lbs.
Red of Campine	Healthy tubers -	574	576	576
	Diseased tubers -	11	9	10
Rykmakers	Healthy tubers -	444	451	452
	Diseased tubers -	21	20	19·8

Results inconclusive.

The bouillie, as well as the sulpho-steatite, appears to have increased the yield, but the difference between each plot is too slight to draw any conclusions.

Further experiments in Campine district.

The following is a summary of a report from the Belgian "Bulletin de l'Agriculture" relative to some further experiments made in the Campine district of Belgium in 1891.

The potato-disease was not very prevalent in the Campine district in 1891, where, as a rule, it is less severe and appears later in the sandy than in the clay soils.

Four different experiments were conducted on private farms, and the results are tabulated below. The dressings used were:—

(*a.*) Bouillie bordelaise, made by adding 20 lbs. of sulphate of copper and 15 lbs. of lime to 100 gallons of water. This was applied at intervals and in varying quantity, 70 to 110 gallons per acre, according to the development of the foliage.

(*b.*) Sulpho-steatite of copper, at the rate of 26¾ to 35½ lbs. per acre, also applied at intervals.

Further experiments in Campine district.

Experiment 1. Area of each plot: 29·9 square yards.
Two applications made, 1st July and 3rd August.

Name of Variety.	Plot.	Preventive Treatment.	Weight of Sound Tubers per Acre.	Weight of Diseased Tubers per Acre.
			Tons.	Lbs.
Mealy red	1	Sulpho-steatite	10·0009	—
	2	Boullie bordelaise	8·2834	—
	3	None	10·1816	77
Juno	1	Sulpho-steatite	10·6994	—
	2	Bouillie bordelaise	8·5423	—
	3	None	8·8884	—
Andersen	1	Sulpho-steatite	8·2834	—
	2	Bouillie bordelaise	8·4560	—
	3	None	8·4560	—
Magnum Bonum	1	Sulpho-steatite	7·8826	—
	2	Bouillie bordelaise	9·4012	—
	3	None	8·1109	—
Red of Campine	1	Sulpho-steatite	6·7309	44
	2	Bouillie bordelaise	5·6948	62
	3	None	5·4361	88

The *phytophthora infestans* caused little or no damage. The Red of Campine suffered from the attacks of the larva of a beetle. The treatment had no injurious action on the foliage.

No injury to foliage from dressing.

Experiment 2. Area of each plot: 29·9 square yards.
Two applications made, 10th July and 4th August.

Name of Variety.	Plot.	Preventive Treatment.	Weight of Sound Tubers per Acre.	Weight of Diseased Tubers per Acre.
			Tons.	Lbs.
Blauputters	1	Sulpho-steatite	6·6756	99
	2	Bouillie bordelaise	8·7546	199
	3	None	7·1545	159
"	4	Bouillie bordelaise	6·0289	161
	5	None	6·0050	159
"	6	Bouillie bordelaise	5·8364	199
	7	None	4·8952	398
"	8	Bouillie bordelaise	7·7192	299
	9	None	4·8948	198

The foliage on the plots treated with bouillie bordelaise remained green longer than that on the others. These plots also yielded tubers of larger size, but not more numerous.

Dressed foliage remained green longer.

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Further experiments in Campine district.

Experiment 3. Area of each plot: 13·1 square yards (except the first, the area of which was 11·4 square yards).

Two applications made, 3rd July and 4th August.

Name of Variety.	Plot.	Preventive Treatment.	Weight of Sound Tubers per Acre.	Weight of Diseased Tubers per Acre.
			Tons.	Lbs.
Red of Campine	1	Bouillie bordelaise	7·3271	—
	2	None	6·4897	—
Anderssen	1	Bouillie bordelaise	6·3251	—
	2	None	6·5005	—
Juno	1	Bouillie bordelaise	9·7590	—
	2	None	9·2166	—
Magnum Bonum	1	Bouillie bordelaise	7·1382	—
	2	None	7·1382	—
Mealy Red	1	Bouillie bordelaise	10·8433	—
	2	None	9·7590	—

No difference between treated and untreated plots.

No difference was observed between the foliage of the treated and untreated plots.

Experiment 4. Area of each plot: 29·9 square yards.

Two applications made, 20th July and 10th August.

Name of Variety.	Plot.	Preventive Treatment.	Weight of Sound Tubers per Acre.	Weight of Diseased Tubers per Acre.
			Tons.	Lbs.
Magnum Bonum	1	Sulpho-steatite	6·4666	—
	2	Bouillie bordelaise	7·2957	—
	3	None	6·5497	—
"	4	Sulpho-steatite	7·6273	—
	5	Boullie bordelaise	7·3036	—
	6	None	6·5504	—
"	7	Sulpho-steatite	7·1299	—
	8	Bouillie bordelaise	7·9590	—
	9	None	7·3788	—
"	10	Sulpho-steatite	7·1390	—
	11	Bouillie bordelaise	7·1728	—
	12	None	5·6968	—
"	13	Sulpho-steatite	6·4666	—
	14	Bouillie bordelaise	8·3016	—
	15	None	5·0335	—

Diseased foliage remained green.

The foliage on the plots treated with bouillie bordelaise remained green longer than that on the others.

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M. Girard's Experiments.

M. Aimé Girard has been good enough to transmit to the Board a copy of a paper, read by him before the National Agricultural Society of France on the 25th May 1892, on the results of his observations and experiments of 1891.

M. Girard states that the losses caused to French agriculture by the potato-disease were much less than usual in 1891, owing, partly to the weather, and partly to the more extended use of copper dressings, the efficacy of which can now be said to be beyond contradiction. During the 1891 season it was arranged with 350 farmers in different parts of France to make extended observations both as regard the progress and the prevention of the disease. The results show that only 41 per cent. of the area under observation was attacked, whilst owing to the extended cultivation of the Richter's Imperator, which is a disease-resisting variety, the attack was very slight in many instances. Two hundred careful observations were made, the results of which are shown below :—

200 observations made.

Regions of the Agricultural Department.	No. of Areas under Observation.	No. of Areas Attacked.	Percentage Attacked.
			Per cent.
North-west	24	13	54
North	45	26	58
North-east	31	10	32
West	30	7	24
Midlands	25	9	36
East	20	12	60
South-west	14	3	21
South	8	2	25
South-east	3	—	—
	200	82	41

From the above table it will be seen that only three regions seriously suffered from the disease. In four departments in the north region 75 per cent. of the area under observation was attacked, whilst in the "Pas de Calais" the proportion attacked reached 77 per cent.

In the North-east, where the disease is generally very severe, the attack was slight.

The attack was also slight in the West and Midlands, as well as in the south where the potato is not widely cultivated.

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M. Girard's experiments.

The areas from which observations were taken are classified by M. Girard as follows :—

Areas not attacked	1. Not treated	77	
	2. Treated	41	
			118
Areas attacked	1. Not treated	9	
	2. Treated	73	
			82
			200

As regards the areas attacked, only nine cultivators neglected to use the bouillie bordelaise and their crops greatly suffered. Whereas the mean yield per acre of potatoes in France in 1891 was 14·31 tons, these nine untreated areas gave only 10·30, 9·94, 9·14, 8·75, 8·75, 8·47, 8·35, 7·95, and 7·15 tons respectively. Had the variety grown been a less resisting one than Richter's Imperator, the result would, it is stated, have been still more striking.

Of 73 dressings only five failed.

Of the 73 growers who, by using the copper sulphate treatment, aimed at preventing a diminution of their crop, 68 were entirely successful and only five failed. Of the five failures, however, four were clearly due to the insufficient quantity of solution used, and thus in one case alone, although two successive treatments were applied, did the remedy fail.

The following table gives the results of an experiment at Clichy-sous-Bois, where the disease was of considerable intensity. Four varieties of potatoes were planted in parallel plots under similar conditions, two thirds of each plot being sprayed, and the remaining third left as a control plot.

Experiment at Clichy-sous-Bois.

Variety.	Area Sprayed. 7·9 Perches.			Area Unsprayed. 7·9 Perches.		
	Total Weight of Crop.	Diseased.		Total Weight of Crop.	Diseased.	
		Weight.	Per Cent.		Weight.	Per Cent.
	Lbs.	Lbs.	%	Lbs.	Lbs.	%
Jeuxey	1,449	5·1	0·35	1,275	190·7	14·9
Gelbe Rose	1,529	2·2	0·14	1,465	178·0	12·8
Red Skinned	1,582	2·2	0·13	1,426	30·0	2·1
Richter's Imperator	2,004	2·0	0·09	1,698	40·0	2·4

For purposes of comparison the yield of the unsprayed plots has been calculated on the same area as that of the sprayed plots.

Bouillie of copper and soda used.

The dressing used was the bouillie of copper and soda, consisting of 20 lbs. of sulphate of copper, 30 lbs. of soda crystals, to 100 gallons of water, and from the above table its efficacy is self-evident. The disease had only a slight effect on such disease-resisting varieties as Red Skinned and Richter's Imperator, but

the difference between the sprayed and unsprayed plots of Jeuxey and Gelbe Rose was very striking.

M. Girard's experiments.

Most of the observers used the copper and lime dressing, the majority giving one treatment only. In 64 cases out of 100 one treatment properly applied proved sufficient.

As regards the cost of treatment, M. Girard remarks that, even in a season when the disease is not severe, it pays to spray.

It has long been observed that some varieties of potatoes resist the disease more than others. In the experiments of 1890 Richter's Imperator was observed to possess disease-resisting qualities in a high degree, and this observation was confirmed in 1891. In one instance there was only 1 per cent. of this variety diseased, whereas two other varieties had 25 per cent. to 30 per cent. attacked.

Diminution of yield in some instances.

In 1889 and 1890 it was noticed that the application of the dressing increased the yield, the increase being 41 per cent., in an experiment with the Jeuxey variety. On the other hand there were instances where the yield was diminished. Careful observations were therefore made on this point in 1891.

The following figures give the increase in weight of the yield of a treated plot of 7·9 perches over one of a similar size which was not treated :—

Variety.	Increase.	
	In Weight.	Per Cent.
	Lbs.	%
Jeuxey	359	33·1
Gelbe Rose	240	18·6
Red Skinned	185	13·2
Richter's Imperator	321	19·3

Increased yield of Richter's Imperator.

The following nine cases show the increase of yield of Richter's Imperator by the treatment :—

	Yield of Crop on		Increase of Yield through the Treatment.	
	3·9 Perches, Treated.	3·9 Perches, Not Treated.	In Weight.	Per Cent.
	Lbs.	Lbs.	Lbs.	%
1.	1,012	704	308	43
2.	682	506	176	34
3.	1,071	748	323	43
4.	748	506	242	47
5.	970	537	433	80
6.	713	616	97	15
7.	845	594	251	40
8.	704	627	77	12
9.	770	550	220	40

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M. Girard's experiments.

As regards the diminution of yield by the treatment, the experiment at Joinville-le-Pont may be mentioned, where in 1891 the disease was very slight. There 32 varieties of potatoes were cultivated experimentally, and the results were very marked. The 16 non-resisting varieties gained from 1·2 to 20·7 per cent. by the treatment, whilst the disease-resisting varieties lost from 4 to 8 per cent. of their yield. In one case (but an error is suspected) there was a diminution in yield of 27 per cent.

In nearly every instance, however, an analysis of the tubers has shown an increase of about 1 per cent. of starch.

M. Girard's conclusions.

The following are the conclusions arrived at by M. Girard on this point:—

1. When a field is badly attacked by the disease, the weight of the crop on the dressed plots is always greater than on the undressed plots.
2. When, on the contrary, the field is not attacked by the disease, certain disease-resisting varieties yield a slightly diminished crop by the treatment, from 5 to 6 per cent. as a rule.

Experiments with disease-resisting varieties.

It would seem therefore as though it were best to leave the resisting varieties alone. It might be so if one was certain that the potatoes would not be attacked, or only slightly. But to show that it is best always to use the treatment the result of two observations made in 1891 are recorded by M. Girard as follows:—

Joinville-le-Pont.

1. At Joinville-le-Pont, in a porous soil, where the disease was very slight.

Disease-resisting Varieties.	Dressed Plot. 3·9 Perches.			Undressed Plot. 3·9 Perches.			Decrease of Yield by the Treatment.	
	Total weight of Crop.	Diseased.		Total weight of Crop.	Diseased.			
		Weight.	Per cent.		Weight.	Per cent.	Weight.	Per cent.
	Lbs.	Lbs.	%	Lbs.	Lbs.	%	Lbs.	%
Richter's Imperator -	715	Nil.	Nil.	748	Nil.	Nil.	33	4·4
Red Skinned - -	543	„	„	567	„	„	24	4·2

Clichy-sous-Bois.

2. At Clichy-sous-Bois, in a loamy soil, where the disease was of considerable severity.

Disease-resisting Varieties.	Dressed Plot. 3·9 Perches.			Undressed Plot. 3·9 Perches.			Increase of Yield by the Treatment.	
	Total weight of Crop.	Diseased.		Total weight of Crop.	Diseased.			
		Weight.	Per cent.		Weight.	Per cent.	Weight.	Per cent.
	Lbs.	Lbs.	%	Lbs.	Lbs.	%	Lbs.	%
Richter's Imperator -	1,001	11	·09	849	20	2·4	161	19·3
Red Skinned - -	790	11	·13	713	15	2·1	95	13·2

These tables show that even with resisting varieties, and in spite of the results at Ivinville, the neglect of the treatment would have involved a loss per acre of 2·90 tons as regards the Imperator, and of 1·68 tons in the Red Skinned at Clichy. M. Girard's experiments.

M. Girard points out, however, that it must be remembered that several conditions are essential to insure success. The ingredients must be pure, they must be mixed with care, and the distributor must be in good working order. The copper sulphate crystals should be blue in colour and limpid. Conditions essential to success.

The method usually adopted of dissolving them in the field just before using the dressing, is slow and inconvenient, and the following process is recommended instead.

At the farm-house, 40 lbs. of sulphate of copper crystals should be broken up into small fragments, and placed in a tub into which are poured 10 gallons of water, which should be nearly at the boiling point. The crystals soon dissolve, and when the solution is cold it is transferred to a small cask for transport to the field. One gallon of this solution is then poured into a larger tub or cask in which the mixture is to be completed, a wooden bucket being used for this purpose. The bucket should be marked inside to show the level of one gallon of liquid, and the larger tub should be similarly marked to show the level of 20 gallons of liquid. The gallon of solution, which contains 4 lbs. of dissolved copper sulphate, is then diluted with 10 gallons of water, and the large tub is subsequently filled to the level denoting 20 gallons of liquid, by the re-agent which will precipitate the copper in the form of bouillie. Copper.

Should it be desired to employ soda as the re-agent, it is recommended that care should be taken to exclude the soda crystals known as "mixed crystals," which contain more sulphate than carbonate. For convenience again, a stronger solution of soda may be made at the house. In this instance a metal receptacle may be employed, marked to show the level of 10 gallons, and in this 120 lbs. of soda crystals are dissolved in 10 gallons of lukewarm water. When cold, this solution is taken to the field and poured into the cask which contains the copper sulphate solution, in the proportion of one gallon for the one gallon of copper sulphate used. Water is then put into the large cask up to the level denoting 20 gallons. The mixture must be thoroughly stirred and used without delay. This quantity of solution will suffice to treat from 21 to 25 perches. Soda.

If lime is desired as the re-agent, great care must be taken in its selection. It should always be previously tested as follows:— Immerse a small quantity of the lime in cold water until effervescence from the solid lime ceases. Transfer the mass from the water to a plate. If the lime crumbles entirely into powder it is good lime, but if there remain stony or gritty particles it will not give good results. Lime.

Good lime being chosen, it should be weighed and then slaked. A known quantity of water is then added, and the lime water thus obtained is taken to the field, and a quantity, containing

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M. Girard's experiments.

5 or 6 lbs. of quick-lime in solution, is poured into the barrel already containing the solution of 4 lbs. of copper sulphate, sufficient to make 20 gallons of bouillie.

Sucrated solution.

Lastly, if the sucrated solution of M. Perret is preferred, it is well to dissolve at the farmhouse not only the copper sulphate, but also the molasses, which should be dissolved in hot water, so as to take into the field solutions of known strength and lime water of known composition. The operation of mixing with the aid of a measured bucket or tub will present no difficulty.

M. Girard states that it is at the end of June, or at the time when the leaf reaches its fullest development, that the dressing should be applied in quantities of from 140 to 160 gallons per acre. It is an important fact to remember that the total leaf surface of a potato crop is equal to six times the area of the field. It is better to apply the dressing in one treatment, as the damage to the foliage by the operator passing through the rows is then reduced to a minimum.

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Experiments at Göttingen.

EXPERIMENTS AT GÖTTINGEN.

The Board have received from Dr. Liebscher, of the Agricultural Institute attached to Göttingen University, a report on a series of experiments conducted by him to determine the value of bouillie bordelaise and sulpho-steatite of copper as remedies for potato-disease.

Experiments of 1890.

The experiments were carried out in 1890, 1891, and 1892 in the fields attached to the Institute. In the first of the years mentioned a large plot, planted with many different varieties of potatoes, was dressed with the bouillie bordelaise. The first dressing was applied on June 28th, when traces of the disease were beginning to appear on the leaves of the plants. A somewhat weak solution of sulphate of copper was used (15 lbs. of sulphate of copper to 100 gallons of water) at the rate of 27 gallons per acre. Four weeks later the plants were again dressed with bouillie bordelaise of the usual strength (20 lbs. of sulphate of copper to 100 gallons of water) at the rate of 44½ gallons per acre.

The treatment had practically no effect, a result which Dr. Liebscher thinks is probably to be attributed to the first dressing having been applied too late. The early varieties of potatoes were attacked with the disease on both the dressed and undressed plots, but the later sorts, which formed the major portion of the crop, entirely escaped.

Experiments of 1891.

In 1891 the experiment was restricted to a variety of potatoes known to be particularly susceptible to disease, viz., the Biscuit

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potato. The experimental field was about 1¼ acres in extent, and divided into three equal portions, one of which was left untreated as a control plot, while the remaining two sections received three dressings of bouillie bordelaise and sulpho-steatite of copper respectively. The bouillie employed was a 1½ per cent. solution of sulphate of copper (15 lbs. of sulphate of copper to 100 gallons of water), applied on each occasion at the rate of 22¼ to 27 gallons per acre. The sulpho-steatite of copper was applied according to the directions given by the firm supplying this material.

Notwithstanding the fact that the first application of these dressings was made immediately after the plants began to rise, the disease made its appearance and spread so rapidly on all three plots that by the beginning of August, when the dressing was applied, the potato haulms were already dying off. The dressed plants, however, remained green longer than those in the central plot, but this difference amounted to a few days only in the case of the section treated with sulpho-steatite of copper, while the plants dressed with bouillie bordelaise remained green seven to 14 days longer than those of the untreated plot. The result was as follows:—

Results.

Yield of Potatoes per Acre.

—	Sound.	Diseased.	Total.	Increased Yield by Dressing.
	Cwts.	Lbs.	Cwts.	Cwts.
Control plot - -	17·7	47	17·3	—
Plot dressed with sulpho-steatite.	19·6	47	19·2	1·9
Plot dressed with bouillie bordelaise.	26·8	80	26·1	8·8

Dr. Liebscher remarks that the application of copper dressing did not prevent a total failure of the crop as regards quantity, although the increased yields of 1·9 and 8·8 cwts. per acre respectively cover the cost of the treatment. He adds that a better result would probably have been obtained in 1891, which was a wet year, if the dressings had been applied weekly instead of on three occasions only.

Experiments of 1892.

The experiments were repeated in 1892 on a field of potatoes of the same area (about 1¼ acres), divided into three sections as before, one of which was left untreated while the remaining two were dressed with bouillie bordelaise and sulpho-steatite of copper respectively. Fourteen varieties of potatoes were planted across the three plots. The first application of the dressings took place on 7th and 8th of June. The treatment was repeated on the 22nd and 23rd of June. The final dressing of bouillie bordelaise

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was applied on 18th and 19th of July, while the third application of sulpho-steatite of copper was made on 4th August.

No disease.

Owing to the dryness of the summer the disease did not make its appearance in Göttingen, and all the potatoes remained perfectly sound. At the end of August from four to six weeks after the last dressing, there were clearly visible signs that the copper preparations had injuriously affected the foliage of all the dressed potatoes, the tubers were therefore taken up from the three plots separately.

Dressings injure plants.

This injury Dr. Liebscher says is not to be regarded as an acute poisoning as would easily arise if copper dressings were applied in too great strength and in large quantities. For the injury did not make its appearance suddenly and immediately after the application of the copper solution, but it first became visible about four weeks after the last dressing in the form of a curling of the foliage which spread gradually from one variety to another at a period when very few traces of the copper preparation were to be seen on the leaves. He remarks that, unfortunately, it was not ascertained whether the injury sprang from the copper which had been carried into the earth or from that which had been dissolved by the rain and dew on the leaves. He adds, however, that the fact that the otherwise sound potatoes had been injured by the copper was so manifest, that there could have been no possible doubt about the matter, even if the yield as regards quantity had not been determined. The yields of the different varieties were however weighed, and the results fully corroborated the observations made as to the injury done to the plants by the dressings.

Yield per acre.

The produce of each kind of potatoes calculated to the acre, was as follows:—

Variety.	Untreated Plot.	Plot dressed with Bouillie Bordelaise.	Plot dressed with Sulpho-steatite of Copper.
	Tons.	Tons.	Tons.
Simson	9·1	7·1	3·5
Aspasia	9·7	8·9	7·5
Snowrose	12·4	9·6	8·7
Dr. Eckenbrecher	11·8	8·6	7·4
Athene	11·1	8·5	7·1
Minster Lucius	11·7	8·9	8·0
Juno	9·1	7·2	6·6
Imperator	13·7	9·1	8·4
Prof. Oehmischen	11·1	7·8	7·3
Fürst von Lippe	10·0	8·4	7·1
Reichskanzler	8·4	7·6	6·6
Blaue Riesen	11·2	9·4	8·2
Saxonia	9·1	7·6	6·9
Magnum Bonum	11·9	11·2	10·0
Average	10·7	8·6	7·4
„ in relative figures.	100	80	69

Commenting on the above Dr. Liebscher observes that each of the 14 varieties shows without exception that in 1892 a year in which the potato crop was abundant owing to the absence of disease, the application of bouillie bordelaise and sulpho-steatite of copper reduced the yields by about 20 per cent. and 30 per cent. respectively. He maintains that the decreased yield was undoubtedly the result of a chronic poisoning of the plants by the copper. The experiments were conducted with such care that there can be no question of the application of an excessive quantity of the dressings, nor of defects in their preparation. Dr. Liebscher concludes therefore that the results point to an unexpected secondary action of the copper salts, which is so significant that he considers it necessary to warn farmers and others against the indiscriminate use of copper dressings. He points out however that although these preparations may act as a poison to sound plants they are equally poisonous to the fungus causing the potato disease. Many experiments, he observes, have proved that these dressings arrest the development of the fungus, and though they may not be capable of completely preventing a failure of the crops in wet years favourable to the spread of fungus, yet their application in years when the disease makes its appearance may considerably reduce the loss arising from the disease.

Experiments at Göttingen.

Agriculturists warned against indiscriminate use of dressings.

Dr. Liebscher regards the so-called preventive treatment, which consists in applying the dressings before the disease makes its appearance, as absolutely worthless. He remarks that by adopting this method an undesired injury to the growth of the potatoes through the copper is sure to arise, while the desired injurious effect on the fungus will depend on whether the weather is favourable to the appearance of the disease or not.

Preventive treatment worthless.

On the other hand when the disease has once made it appearance Dr. Liebscher recommends the application of bouillie bordelaise, which he says is much more effective than the sulpho-steatite of copper. He advises, further, that its application should not be limited to two or three dressing, but that the plants should always exhibit traces of the dressings, even though in wet weather the operation should have to be repeated every week.

Dr. Liebscher concludes by remarking that although the bouillie bordelaise may injure the potato plants, it is much more injurious to the potato fungus, and that therefore the final results of its application may be represented by a favourable effect on the yield of the crop. He does not therefore advise the discontinuance of the use of copper dressings, but he cautions farmers against the inconsiderate systematic application of such dressings and against entertaining the all too sanguine expectations which attended the introduction of these preparations of copper.

Dr. Liebscher's conclusions.

Dr. Liebscher proposes to continue his experiments in the current season should there be an outbreak of potato disease.

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EXPERIMENTS AT DRESDEN.

Experiments at Dresden.

The Board are indebted to Dr. Steglich, Director of the Agricultural Experiment Station at Dresden, for a copy of a paper read by him in March 1893 before the Teltower Agricultural Society at Berlin respecting the results of some experiments conducted at Dresden in 1891, with copper and iron solutions as remedies for potato-disease.

The liquid dressings used in Dr. Steglich's experiments consisted of ordinary bouillie bordelaise (sulphate of copper, lime, and water), sulpho-steatite of copper (a powder composed of about 10 per cent. sulphate of copper to 90 per cent. of soapstone), and a solution of sulphate of iron, lime, and water. The sulpho-steatite of copper was applied by means of a pair of bellows, while the liquid dressings were distributed by a special spraying apparatus.

Three applications.

There were three applications of the bouillie bordelaise and sulphate of iron, and on each occasion 110 gallons of each of these solutions were used. The first dressing was the ordinary 2 per cent solution, but the second and third were stronger, viz., 2·5 per cent. and 4 per cent. respectively.

The powder was also applied three times; in the first dressing 105 lbs. were used, but this quantity was increased to 145 lbs. for each of the subsequent applications.

The experimental plots were four in number; each plot was 11·9 perches in area, and divided into six sections on which the following varieties of potatoes were grown:—

1. Saxon Zwiebel. 2. Lerche. 3. Biscuit. 4. Champion. 5. Andersen. 6 Magnum Bonum.

In order to ensure an outbreak of the disease, manure containing diseased potatoes was spread over the plot, and diseased seed was purposely sown. Several varieties of potatoes were grown as it was felt that this course would not only facilitate an outbreak of the disease, but would at the same time indicate the behaviour of the different varieties under the treatment.

The processes of tillage, manuring, planting, and similar operations were carried out in a uniform manner on all the plots. The growth of the plants was quite normal.

Dates of application.

The dressings were applied to plots, II., III., and IV. on 12th June, 17th July, and 15th August. Plot II. was treated with bouillie bordelaise, plot III. with sulphate of iron, and plot IV. with sulpho-steatite of copper Plot I. was not treated, and served as the control plot.

Experiments at Dresden.

The results of the treatment are shown below :—

Results.

Plot I. Undressed or Control Plot.

Variety.	Date of Appearance of Disease.	Date when the Haulms Died Off.	Yield in Lbs.	Per-centage of Diseased Tubers.	Per-centage of Starch.
1. Saxon Zwiebel -	27th July	25th Aug.	110	14·6	14·7
2. Lerche - -	25th „	22nd „	136	14·0	14·5
3. Biscuit - -	26th „	25th „	86	38·5	13·0
4. Champion - -	28th „	26th „	263	6·3	16·6
6. Andersen - -	28th „	4th Oct	255	—	14·7
6. Magnum Bonum -	27th „	20th Sept.	261	1·3	12·2

Bouillie bordelaise.

Plot II. Dressed with Bouillie Bordelaise.

Variety.	Date of Appearance of the Disease.	Date when the Haulms Died Off.	Yield in Lbs.	Yield compared with Plot I.	Per-centage of Diseased Tubers.	Per-centage of Diseased Tubers compared with Plot I.	Per-centage of Starch.	Per-centage of Starch compared with Plot I.
				Lbs.				
1. Saxon Zwiebel -	27th July	8th Sept.	168	+26½	13·7	−0·9	14·9	+0·3
2. Lerche - -	26th „	30th Aug.	148½	+6	14·8	+0·8	15·1	+0·6
3. Biscuit - -	27th „	5th Sept.	142	+25½	4·1	+2·5	14·3	+1·3
4. Champion - -	29th „	7th Oct.	294	+14	5·2	−1·1	17·9	+1·3
5. Andersen - -	29th „	—	300	+20½	0·7	+0·7	17·1	+2·4
6. Magnum Bonum	28th „	27th Sept.	221	+9	1·0	−0·3	14·1	+1·9

Sulphate of iron.

Plot III. Dressed with Sulphate of Iron.

1. Saxon Zwiebel -	26th July	23rd Aug.	102½	−3½	10·0	−4·6	13·5	−1·2
2. Lerche - -	26th „	20th „	121	−7	17·2	+3·2	14·3	−0·3
3. Biscuit - -	26th „	22nd „	74	−5½	23·9	+1·6	12·5	−0·5
4. Champion -	28th „	25th Sept.	251	−5½	7·0	+0·7	16·6	+0
5. Andersen -	27th „	29th „	253	−1	1·3	+1·3	14·5	−0·2
6. Magnum Bonum	28th „	18th „	176	−11	—	−1·3	12·5	+0·3

Sulpho-steatite of copper.

Plot IV. Dressed with Sulpho-steatite of Copper.

1. Saxon Zwiebel -	27th July	26th Aug.	122	+5½	14·3	−0·3	15·1	+0.4
2. Lerche - -	27th „	23rd „	141	+2½	15·1	+1·1	14·7	+0·2
3. Biscuit - -	27th „	25th „	98	+5½	36·9	−1·6	13·8	+0·8
4. Champion - -	27th „	26th Sept.	263	+0	6·7	+0·4	13·9	−2·7
5. Andersen - -	28th „	6th Oct.	263	+3½	1·2	+1·2	15·8	+1·1
6. Magnum Bonum	28th „	22nd Sept.	200	−¼	—	−1·3	12·5	+0·3

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Experiments at Dresden

Appearance of disease.

From the foregoing table of results it follows that as all the plots and all the varieties of potatoes were attacked by the disease, none of the dressings had the effect of entirely preventing its appearance. The disease first broke out on July 25th, after a period of rain, on the undressed plot among the Lerche potatoes, and quickly spread to the two neighbouring varieties, Biscuit and Saxon Zwiebel. It then attacked the Magnum Bonum, afterwards the Champions, and finally the Andersens. By the 29th July the disease had invaded the whole of the experimental field. The intensity of the attack on the different varieties could be observed by the discolouration of the foliage. The effects of the dressings as indicated by the appearance of the plants were as follows:—The plot dressed with sulphate of iron presented the most unfavourable appearance; next in order came the undressed section; the plot treated with sulpho-steatite of copper looked only slightly better; the plants on the plot dressed with bouillie bordelaise presented the most favourable appearance.

At first the aspect of the experimental field seemed to give the impression that the power of resistance possessed by the individual varieties to the disease had far more effect than the application of the dressings. Later on, however, this feature was changed in so far that the haulms of the several varieties died off on the dressed plots in the order indicated when describing the visible effects of the dressings, viz.:—(1) on the plot dressed with sulphate of iron; (2) on that treated with sulpho-steatite of copper; (3.) on the plot dressed with bouillie bordelaise.

The yields and percentages of starch confirmed these outward indications, for the yield of the plot dressed with the bouillie was the highest, then followed the plot treated with sulpho-steatite of copper which yielded a crop only slightly in excess of the untreated plot, while the section treated with sulphate of iron produced the least. The percentages of starch followed the same order.

Sulphate of copper best.

Thus it would appear that the solution of sulphate of copper and lime acted as a good preservative; the sulpho-steatite of copper had only a slight preservative effect; and the sulphate of iron solution was almost injurious.

Dr. Steglich observes that the noxious action of the sulphate of iron was to be anticipated and that it arises from the poisonous properties of the protoxide of iron present in this material.

With reference to the relatively high percentage of diseased tubers yielded by the plots treated with the dressings which proved effective, Dr. Steglich remarks that for this there is the very simple explanation, that the nature of the dressings and the mode of their application are such that they can only have effect in arresting the progress of the disease on the foliage of the plants; the successfully treated haulm remains greener longer and thus enables the plant to proceed with the development of

Experiments at Dresden.

tubers. Hence the success of the treatment is in the first place to be sought for in an increased yield, and secondly in a diminution of the percentage of diseased tubers.

The success which attended the use of the copper dressings may be better seen in the following table which shows the net value per acre of the increased yield of healthy tubers obtained by application of the dressings, less the cost of treatment. Dr. Steglich has omitted from this statement the results yielded by the plot dressed with sulphate of iron as this preparation proved to be practically useless.

Results of treatment.

Yield per Acre of Healthy Tubers.

—	Saxon Zwiebel.	Lerche.	Biscuit.	Champion.	Andersen.	Magnum Bonum.
1. Bouillie Bordelaise:— Yield of dressed plot in tons	Tons. 5·25	Tons. 4·77	Tons. 3·00	Tons. 10·07	Tons. 10·78	Tons. 7·91
Yield of undressed or control plot in tons.	3·39	4·42	1·90	8·91	9·22	7·16
Increased yield from the treatment in tons.	1·86	0·35	1·10	1·16	1·56	0·75
Value of increased yield, at 51*s.* per ton.	*s. d.* 94 11	*s. d.* 17 10	*s. d.* 55 11	*s. d.* 56 6	*s. d.* 79 5	*s. d.* 40 2
Less cost of treatment -	13 8	13 8	13 8	13 8	13 8	13 8
Net gain - -	81 3	4 2	42 3	42 10	65 9	26 6
2. Sulpho-steatite of copper:— Yield of dressed plot in tons	Tons. 3·77	Tons. 4·33	Tons. 2·23	Tons. 8·87	Tons. 9·38	Tons. 7·24
Yield of undressed or control plot,	3·39	4·22	1·90	8·91	9·22	7·16
Increased yield from the treatment,	0·38	0·11	0·33	—	0·16	0·08
Value of increased yield at 51*s.* per ton.	*s. d.* 19 5	*s. d.* 5 7	*s. d* 16 10	*s. d.* —	*s. d.* 8 2	*s. d.* 4 1
Cost of treatment - -	24 4	24 4	24 4	24 4	24 4	24 4
Net loss - -	4 11	18 9	7 6	24 4	16 2	20 3

Cost of treatment.

The following are the items included under "Cost of Treatment" calculated to the acre:—

1. Bouillie bordelaise:—	£	*s.*	*d.*
First application = 44½ gallons of a 2 per cent. solution.			
9 lbs. of sulphate of copper - - -	0	2	0
9 lbs. of lime - - - - -	0	0	1
Second application = 44½ gallons of a 2·5 per cent. solution.			
11½ lbs. of sulphate of copper - -	0	2	7
11½ lbs. of lime - - - -	0	0	1

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	£	s.	d.
Cost of materials for first and second applications	0	4	9
Third application = 44½ gallons of a 4 per cent. solution.			
18 lbs. of sulphate of copper - -	0	4	0
18 lbs. of lime - - - -	0	0	2
Labour, preparation and distribution of three dressings - - - -	0	4	3
Wear and tear of spraying apparatus -	0	0	6
	0	13	8
II. Sulpho-steatite of copper:—			
First application 43 lbs. at 15*s* per cwt. -	0	5	9
Second application 59 lbs. at 15*s*. per cwt. - -	0	8	0
Third application 59 lbs. at 15*s*. per cwt -	0	8	0
Labour and wear and tear of apparatus -	0	2	7
	1	4	4

Dr. Steglich's conclusions.

From the above results Dr. Steglich concludes that the treatment of potatoes with bouillie bordelaise is not only effective against the *phytophthora infestans*, but also profitable, since the costs of the treatment are fully covered, and in most cases there is a considerable balance to the good. He thinks that the cause of the indifferent results obtained by the use of the sulpho-steatite of copper may perhaps lie in the fact that the powdery preparation conveys too small a quantity of copper in active form to the plants, and that a large proportion of the dressings (about 50 per cent.) is dissipated by the wind. But it should also be noted that the application of this remedy costs nearly twice as much as that of the bouillie bordelaise, so that when the results are not very successful the expense of its application are never covered, while even with very favourable results the cost of the treatment absorbs a disproportionately large share of the gross profit obtained by its adoption.

Experiments on larger scale at Limbach.

Simultaneously with the carrying out of the above experiments at Dresden, an experiment with bouillie bordelaise was conducted on a larger scale under the direction of Dr. Steglich on a farm at Limbach.

A field of 22 acres sown with Magnum Bonum was selected for the experiment, and the dressing was distributed over the entire field with the exception of a piece of 1¼ acres, which was reserved as a control plot. The bouillie was not applied until late in the season, at the beginning of August, when the disease had already invaded the field in every part. The copper solution was of the ordinary strength, 2 per cent., and was distributed at the rate of 46 gallons per acre. A fortnight after the dressing a remarkable difference could be observed between the colour of the foliage of the dressed and undressed potatoes. By the beginning of September the haulms on the untreated plot were

quite dead, while the dressed plants remained green until the end of the month.

Experiments at Limbach.

The results, calculated to the acre, were as follows:—

Results.

	Cwts.
Yield per acre of the dressed plot -	97·6
„ „ undressed plot -	74·6
Increased yield from the dressing	23·0

	£	s.	d.
Value of increased yield at 2s. 6d. per cwt. -	2	17	6
Less cost of treatment:—			
46 gallons of 2 per cent. solution.			
9·2 lbs. of sulphate of copper - 1 10			
9·2 „ lime - - - 0 1½			
Labour and wear and tear of apparatus - - - - 1 5½			
	0	3	5
Net profit per acre by the treatment - -	2	14	1

Dr. Steglich points out that at Limbach the results were much more favourable and the cost of treatment lower than in the case of the experiments conducted at Dresden. From the results at Limbach it might be concluded that three applications of the treatment, viz., in June, July, and August, are superfluous, and should be replaced by one dressing only applied in August.

Treatment in August most essential.

Dr. Steglich is, however, of a distinctly contrary opinion. He states that it cannot be denied that the treatment in August is by far the most essential, since the disease does not, as a rule, appear till the end of July or the beginning of August, at least among the later varieties, so that with these the June treatment can, at any rate, be omitted, but it should never be omitted with the early ripening varieties. He adds, however, that in any case the treatment should be commenced in July and repeated in August, as it is important to cope with the disease on its first outbreak.

In explanation of the fact that the single application of the treatment in August at Limbach proved quite as successful as the three applications at Dresden, attention is directed to the protracted and exceptionally luxurious growth of the foliage of the plants in 1891, whereby, even in August and into September, after the disease had been arrested by the treatment, the plants continued to form new leaf-organs, and the leaves remained green and preserved the powers of assimilation. The potato haulms grew to a certain extent away from the disease. Had not the conditions in this respect been so favourable it is asserted that the haulms would have died off in August and the treatment would have been too late to save them. Besides it is possible that the

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Experiments at Limbach.

Further investigations needed to determine period of treatment.

results at Limbach might have been even more satisfactory had the treatment been applied earlier or more often.

Dr. Steglich is of opinion that the question as to the period at which the application of the treatment is absolutely necessary, and as to when it may be omitted, can only be determined by exact physiological and mycological investigations which shall determine what stage of growth of the potato plant is most favourable to the disease. Until then he thinks that it will be advisable to apply an extra and earlier dressing of the bouillie bordelaise, rather than to apply it too late and in too small a quantity.

In his conclusions on the results of these experiments at Dresden and Limburg, Dr. Steglich remarks that the bouillie bordelaise may be regarded as a sufficiently effective, cheap, and practical remedy for checking the disease of the potato caused by the *phytophthora infestans*, and it is desirable that agriculturists should adopt the treatment as one of the regular operations in potato-culture.

He adds that in order to ensure the harmlessness of the copper preparations, it is a primary condition that they should contain no undissolved copper salts; the bouillie bordelaise is always injurious if it contains undissolved sulphate of copper, which may be ascertained by acid reaction.

Comments on Dr. Liebscher's experiments.

Commenting on the unfavourable results of the experiments conducted by Dr. Liebscher at Göttingen, Dr. Steglich remarks that since it cannot be assumed that the solutions used were improperly prepared, it must be concluded that a too strong concentration of the dressings is injurious, and this may arise in consequence of excessive heat and absence of dew (notwithstanding that the dressings have been carefully prepared and properly applied), if the treatment is carried out on a particularly hot day or during the hottest part of the day.

EXPERIMENTS BY DR. P. SORAUER.

Dr. Sorauer's experiments.

In the "Zeitschrift für Pflanzen Krankheiten, 1893," Dr. Paul Sorauer reports the results of a carefully conducted experiment with bouillie bordelaise and sulpho-steatite of copper on two varieties of potatoes known as Six Weeks and Early Blues.

The potatoes were sown in heavy garden soil at the beginning of May 1891, and the dressings mentioned above were first applied on June 3rd. The application was repeated whenever the frequent rains had washed off a large proportion of the copper. The repetition of the dressing was never delayed long enough to permit the natural green tint of the leaves to predominate.

Bouillie bordelaise and sulpho-steatite copper used.

The experiment was carried out in such a way that each of the two plots was divided into three rows, one of which was dressed with the bouillie, the second with the sulpho-steatite, and the third was left untreated.

Dr. Sorauer's experiments.

The growth of the plants was unusually luxuriant and at first uniform in all the rows, later, however, the plants in the dressed rows, especially those dressed with sulpho-steatite of copper, did not grow quite so high as the undressed stocks. On measuring a large number of leaflets on leaves of the same age and situated at the same height on the stalks, it was found that those of the plants which had been dressed with copper were of a slightly smaller size on the average, while at the ripening period the stalks of the dressed plants began to fall earlier although the foliage had not lost its vitality.

The *phytophthora infestans* appeared on 22nd July, and on that day 10 plants in each row were taken up. The average yield of 10 plants at this period was found to be as follows—the weights are small owing, it is stated, to the fact that the potatoes had not arrived at maturity :—

Results on 22nd July.

A.—*Six Weeks Potato.*

	Large Tubers.		Small Tubers.	
	No.	Weight.	No.	Weight.
		Lbs.		Lbs.
1. Plants dressed with bouillie bordelaise.	28	1·9	102	1·5
2. Plants dressed with sulpho-steatite of copper.	33	2·1	119	2·0
3. Undressed plots - -	38	2·9	43	0·9

B.—*Early Blue Potato.*

	Large Tubers.		Small Tubers.	
	No.	Weight.	No.	Weight.
		Lbs.		Lbs.
1. Plants dressed with bouillie bordelaise.	35	2·2	89	1.8
2. Plants dressed with sulpho-steatite of copper.	25	1·3	49	1·0
3. Undressed plants - -	89	6·4	77	1·4

Dressing depressed yield slightly.

Dr. Sorauer remarks that the above figures indicate that the slight depression in the development of the foliage caused by the use of the copper dressings is also reproduced in the yield. In the case of the undressed plants the tubers continued to grow without intermission, for in both varieties these plants yielded many more large tubers than the dressed plants and their total yield in weight was also greater. No diseased tubers were found on July 22nd.

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Dr. Sorauer's experiments.

This result it is observed is an encouragement to leave undressed the very early sorts, which are approaching ripeness about the period when the disease usually makes its appearance, since the crop is then larger, and this is a great consideration in view of the high prices obtained for early potatoes.

Dr. Sorauer observes, however, that so favourable a result is only to be expected when it is possible to harvest the crop immediately on the appearance of the first symptoms of the disease. The effect will be very different if the disease spreads on the foliage even for a few days only, as is shown by the following results which Dr. Sorauer shows to have been obtained on taking up 10 more stocks from each row a week later, *i.e.*, on July 29th. The disease had made much progress in the meantime, the fungus had not attacked the youngest leaves but those next in age, so that although the plants were not hindered from growing they were attacked in their chief organs of activity. Those which had been dressed with the cuprous preparations were not free from the disease, but they exhibited a decidedly better development of foliage than those in the central or undressed rows.

Results a week later.

The yield of 10 plants taken from each row was as under:—

A.—*Six Weeks Potato.*

	Large Tubers.		Small Tubers.		Percentage of Diseased Tubers.
	No.	Weight.	No.	Weight.	
		Lbs.		Lbs.	
1. Plants dressed with bouillie bordelaise.	45	3·2	92	1·8	0·00
2. Plants dressed with sulpho-steatite of copper.	36	2·6	101	2·2	1·98
3. Undressed or control plants -	33	2·6	91	2·6	59·4

B.—*Early Blue Potatoes.*

	Large Tubers.		Small Tubers.		Percentage of Diseased Tubers.
	No.	Weight.	No.	Weight.	
		Lbs.		Lbs.	
1. Plants dressed with bouillie bordelaise.	52	4·6	97	2·6	1·03
2. Plants dressed with sulpho-steatite of copper.	31	2·0	73	1·7	31·8
3. Undressed or control plants -	53	4·5	69	1·9	67·1

In reviewing these results Dr. Sorauer points out that they show that the second variety is more productive than the first. This feature is however of no significance here. The question of weight has to be considered in respect of the individual rows of each variety. It is seen that the superiority in weight observed in the undressed rows on the first appearance of the disease is no longer maintained. The plants dressed with bouillie bordelaise yielded a greater weight of potatoes, especially in large tubers: a fact from which it may be concluded that the preservation of the foliage enabled the tubers, which were in process of full development at the period when the disease first appeared, to continue to grow without interruption, while the growth of the tubers of the control plants, which, on July 22nd, had exhibited a degree of development equal to that of the neighbouring plants, was subsequently hindered by the destruction of their vigorous foliage.

Dr. Sorauer's experiments.

Dressed plants gave greater yield.

Dr. Sorauer remarks that the favourable effects of the treatment, with cuprous preparations, is seen to its full extent when the percentage of tubers attacked with the disease within the week (22nd to 29th July) is compared with the gross yields.

The conclusion he draws from the experiments recorded above is that copper dressings in any case must arrest, to a certain extent, the development of the potato plants, and may reduce the yield of tubers compared with that produced by healthy untreated plants but that the dressings nevertheless increase the yield, as a matter of fact, because they considerably diminish the otherwise, unavoidable loss caused by the *phytophthora*.

Dr. Sorauer's conclusions.

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